

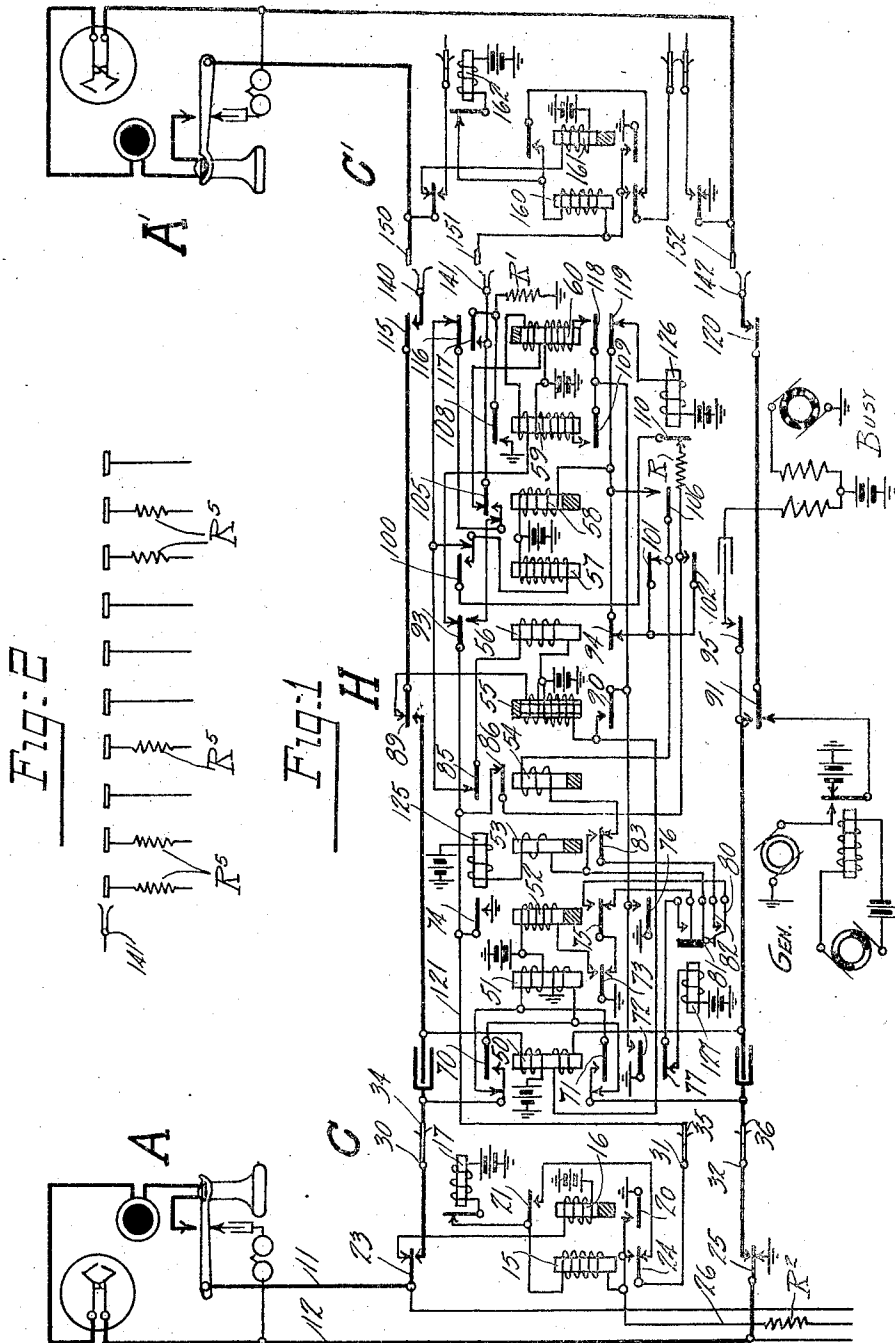
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AUTOMATIC TELEPHONE SYSTEM

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AUTOMATIC TELEPHONE SYSTEM.

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The present invention relates in general to automatic telephone systems, but is more particularly concerned with that type of automatic system in which rotary connector switches are used by calling subscribers to complete connections to called lines. Con-
nectors of this type, as is well known, are adapted to pick out an idle line in a group of lines or if all the lines in a group are busy to notify the calling subscriber that the number called is busy.

An object of the invention is to so arrange the circuits of a connector of this type that the testing of each line which was formerly done by means of two test wipers is now accomplished by means of one.

The particular manner in which this and other results are accomplished will be described fully hereinafter reference being had to the accompanying drawings.

Referring now to the drawings, in Fig. 1 is shown an automatic substation A having a rotary line switch C of well known construction individual thereto. The line switch C in common with a plurality of other similar line switches have access to rotary connectors one of which is shown at H. These connectors are of the Strowger type having the usual set of 100 bank contacts arranged in ten rows or levels. They have access to subscribers' lines similar to the one shown at A, one of which is shown at A'.

In Fig. 2 is shown the test bank and private normal conductor leading from each test contact, these being certain circuit arrangements which are necessary for the operation of the rotary connector switch shown at H.

In order to facilitate the description the invention has been shown applied to an isolated P. A. X. or private automatic exchange but it will be readily apparent that it may be used in a large automatic exchange wherein a call is made through a plurality of selector switches and a connector switch.

Having briefly described the apparatus used in the system, the operation of the same will now be explained in detail. For this purpose it will be assumed that the subscriber at substation A desires to call the subscriber at substation A' and that the latter substation is of the straight or private line type.

When the receiver is removed at substation

A circuit is completed for the line relay 16 of the individual line switch C over the line conductors 11 and 12 in series. Upon energizing, relay 16 at armature 20 completes a circuit which includes the switching relay 15 and the stepping magnet 17 in series, and at its armature 21 connects the test wiper 31 to the above circuit at a point midway between the switching relay and the said stepping magnet. The operation of the line switch C now depends upon whether or not the trunk line with which its wipers are associated is or is not busy. If busy, there will be a ground potential present on the test contact engaged by the test wiper 31. The switching relay 15 will be short circuited and the stepping magnet 17 being supplied with direct ground by way of the said test wiper will operate as a buzzer to advance the wipers 30—32, inclusive, step by step in search of an idle trunk line. However, in the present case it will be assumed that the trunk line with which the switch wipers were in engagement when the receiver was removed at substation A was idle. Under these conditions, upon the energization of the line relay 16, the switching relay 15 will be energized immediately afterwards in series with the stepping magnet 17. It may be stated at this point that the switching relay is of very high resistance so as to prevent the energization of the stepping magnet 17 in series with it. Upon operating, relay 15 disconnects the line conductors 11 and 12 of the calling substation from the winding of the line relay 16 and from ground, respectively, and extends them by way of armatures 23 and 25, wipers 30 and 32, bank contacts 34 and 36, normally closed springs controlled by relay 50, and through the upper and lower windings of the line relay 51 of the connector H. The line relay 51 will be energized over the line circuit and upon attracting its armature 73 completes the circuit of the slow acting release relay 52. Upon energizing, this latter relay at armature 75 prepares the operating circuits of the connector H and at armature 74 places ground on release trunk conductor 121 thereby establishing a holding circuit which extends by way of bank contact 35, test wiper 31, armature 24 and its front contact, winding of the switching relay 15, and the winding of the stepping magnet 17 to battery. It will be understood that this

holding circuit is completed before the line relay 16 has had time to deenergize and hence it serves to maintain the switching relay operated throughout the connection.

5 This holding circuit also extends by way of the private normal conductor 26 through resistance R^2 to multiply connected test contacts in the banks of connector switches which have access to the line of the substation A whereby the said line is protected
10 from intrusion in the well known manner.

The calling subscriber at substation A may now operate his calling device in accordance with the first digit of the desired
15 number thereby producing a series of interruptions in the line circuit of relay 51 which operates in response thereto. At each retraction of its armature 73 the line relay 51 completes a circuit which extends from
20 ground by way of armature 73 and its back contact, armature 75 and its front contact, off normal springs 80 and 81, winding of the slow acting series relay 53, and through the winding of the vertical magnet 125 to
25 battery. The above is the circuit over which the first impulse to the vertical magnet is sent. Upon the first vertical step of the switch shaft the off normal springs are shifted and the remaining impulses to the
30 vertical magnet traverse a new circuit which is the same as the one previously traced except that it includes the off normal springs 80 and 82, and armature 83 and its front contact, relay 53 being now energized. The vertical magnet 125 operates to
35 raise the switch wipers 140—142, inclusive, step by step until they are placed opposite the level of bank contacts in which are located the contact set associated with the
40 line of the substation A'. The slow acting relay 53 which is energized in series with the vertical magnet maintains its armature attracted throughout the vertical operation of the switch and at the termination of their
45 vertical movement deenergizes and transfers the operating circuit to the rotary magnet 126.

The calling subscriber may now operate his calling device in accordance with the
50 last digit of the desired subscriber's number. A series of impulses are thereby produced in the circuit of the line relay 51 which retracts its armature a corresponding number of times, each time sending an impulse of current over the following circuit:
55 ground by way of armature 73 and its back contact, armature 75 and its front contact, off normal springs 80 and 82, armature 83 and its back contact, through the winding of the series relay 54, back contact and armature 101, back contact and armature 94,
60 armature 119 and its back contact, and thence through the winding of the rotary magnet 126 to battery. The slow acting relays 54 and 58 are energized in response to

these impulses, the former relay being in series with the rotary magnet and the latter in multiple. The slow acting relay 58 is constructed so as to retract its armature slightly slower than the slow acting relay
70 54. Magnet 126 operates to rotate the switch wipers step by step until they are placed in engagement with the set of bank contacts in which is terminated the line of the subscriber at substation A' which we will
75 assume are bank contacts 150—152, inclusive. The slow acting relay 58 operates to connect test wiper 141 to the test relays 56 and 57. The operation of the connector H now depends upon whether or not the line
80 of substation A' is busy or idle. If busy, there will be a direct ground potential present on test contact 151. A circuit is then completed extending from ground on said test contact by way of test wiper 141, armature 105 and its front contact, armature 116
85 and its back contact, where the circuit divides, one path extending by way of the normally closed springs controlled by relay 57 and through the said relay to battery, the other one extending by way of back contact
90 and armature 85 and through the winding of relay 56 to battery. Relays 56 and 57 will energize over this circuit. Under these circumstances relay 56 is adjusted to attract its armature 94 before relay 57 attracts armature 102. This adjustment is made so as to prevent any false operation of the rotary magnet at this time and is very easily attained in practice. Relay 56 upon energizing, establishes a locking circuit for itself
100 at armature 93 which circuit extends from ground on release trunk conductor 121 by way of armature 93 and its front contact, normally closed springs controlled by relay 58, armature 116 and its back contact, back contact and armature 85, and through the winding of relay 56 to battery. Relay 56 at armature 95 also places the busy tone on the lower heavy talking conductor thereby
110 notifying the calling subscriber that the desired line is busy. Relay 56 as before mentioned, at armature 94 also opens a point in the rotary magnet circuit. Relay 57 upon operating, establishes a locking circuit for itself at armature 100 extending from
115 ground on release trunk conductor 121 by way of back contact and armature 86, through resistance R, armature 100 and its front contact, and through the winding of relay 57 to battery. The operation of relay 57, however, is without function at this time. The calling subscriber knowing that the desired line is inaccessible at this time will replace his receiver upon the switchhook
120 thereby releasing the connector H and the line switch C in the well known manner.

Having described the operation of the connector H when the called line was busy it will now be assumed that the line of the
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substation A' was idle when connection thereto was attempted. Under these circumstances there will be no ground potential on test contact 151 and no circuit will be completed on test relays 56 and 57. Then following the deenergization of the slow acting relay 58 a circuit is completed extending from ground on release trunk conductor 121 by way of armature 93 and its back contact, upper winding of relay 59, upper winding of relay 60, back contact and armature 105, test wiper 141, test contact 151, winding of the switching relay 160, and through the winding of the stepping magnet 162 to battery. Relays 160, 60 and 59 energize over this circuit: however, due to a mechanical interlocking device controlled by the armature of the line relay 161 which is now normal, the switching relay 160 only attracts its armatures enough to disconnect the line of the subscriber at substation A' from its normal battery and ground connections in the line switch C'. Relay 60 upon energizing, establishes a locking circuit for itself at armature 118, at armature 117 places ground on test wiper 141 through resistance R', and at armatures 115 and 120 completes the ringing circuit. Relay 59 upon energizing, establishes a locking circuit for itself at armature 109, and at armature 108 places direct ground on test wiper 141. When the relay 60 energizes ringing current is intermittently projected over the line of the called substation A' until the subscriber thereat responds. When this occurs a path for direct current is provided over the line loop of the called subscriber through the upper winding of the ring cut off relay 55 to battery. Relay 55 energizes over this circuit, establishes a locking circuit for itself at armature 90 and at armatures 89 and 91 cuts off the ring and at the front contacts of these armatures finally completes the talking connection. Conversation may now be carried on between the subscribers at substations A and A' battery being supplied to the calling subscriber from the windings of the line relay 51 and battery being supplied to the called subscriber from the windings of the back bridge relay 50. It will of course, be understood that the back bridge relay 50 energizes over the line loop at substation A' and operates to reverse the battery over the line of the calling substation A to operate a meter or for any other desirable purpose.

When the conversation is completed both subscribers will replace their receivers thereby causing the release of the connector H and the line switch C. If the calling subscriber at substation A hangs up before the called subscriber only the line switch C will be released. This is accomplished in the following manner: upon the receiver being replaced at the calling substation the circuit of the line relay 51 is broken and upon this relay deenergizing, the circuit of the slow acting release relay 52 is opened. Relay 52 upon retracting its armatures, removes ground from the release trunk conductor 121. Upon relay 51 retracting its armature and before the deenergization of relay 52 an impulse of current is sent to the slow acting relays 54 and 58. Upon operating, relay 58 serves to remove ground through the upper windings of the relays 59 and 60 from the release trunk conductor 121. Ground is therefore removed for a short interval from the release trunk conductor 121, the circuit of the switching relay 15 of the line switch C is thus broken and upon its deenergization the line switch C assumes its normal position. Upon the deenergization of relay 58, ground is replaced on the release trunk conductor 121 over the following circuit; ground by way of front contact and armature 108, armature 117 and its front contact, armature 105 and its back contact, upper winding of the switching relay 60, upper winding of relay 59, back contact and armature 93, and thence to the release trunk conductor 121. In the above manner the connector H is prevented from being released until the called subscriber replaces his receiver upon the switchhook. When the called subscriber hangs up, the back bridge relay 50 deenergizes and at armature 77 completes the release magnet circuit. Had the called subscriber hung up first the connector H would be released immediately upon the calling subscriber replacing his receiver upon the switchhook in a well known manner.

Having described the operation of the connector H when a connection is made with a straight line, its operation will now be explained when the subscriber at substation A desires to call an operator who has several trunks listed on the same number. In this case, the connector H is adapted to select and connect with an idle one of these trunks or if all are busy to notify the calling subscriber of this fact. Where there are a number of trunks listed under the same number the private normal conductor leading from each test contact has a resistance in it. This is shown diagrammatically in Fig. 2. The last trunk of the group, however, has its private normal conductor connected in the usual manner. The resistances R and R' in the connector H are all of equal value, say 500 ohms. The resistance R² and the several resistances R⁵ are also of the same value. It will of course be understood that this resistance is only comparative and might be of any value necessary to secure the proper operation of the connector switch H under various operating conditions.

To proceed, it will be assumed that the subscriber at substation A has removed his receiver and operated his calling device for the first digit of the desired number. The

line relay 51 has in the usual manner controlled the operation of the vertical magnet 125 in stepping the switch opposite the level of bank contacts in which is located the desired group of trunk lines.

The calling subscriber may now operate his calling device for the last digit of his desired number thereby producing a series of interruptions in the circuit of the line relay 51 which deenergizes a plurality of times in response thereto. As before, at each retraction of its armature 73 an impulse of current is sent to the rotary magnet 126 in series with the slow acting relay 54 and in multiple with the slow acting relay 58. The rotary magnet 126 operates to rotate the switch wipers into engagement with the set of banks associated with the first trunk line of the group. The slow acting relay 58 operates to connect the test wiper 141 to the test relays 56 and 57. If this first trunk line may be busy a ground potential will be present on test contact engaged by test wiper 141 through a resistance of 500 ohms. The test relay 56 is so adjusted that it will not energize in series with 500 ohms. An energizing circuit for relay 57, however, is now effective extending from the grounded test contact engaged by test wiper 141, by way of the said test wiper, armature 105 and its front contact, armature 116 and its back contact, normally closed springs controlled by relay 57, and through the winding of said relay to battery. Upon energizing, relay 57 at armature 100 establishes a locking circuit for itself and at the same point breaks its connection to the test wiper 141. It will be noticed that the locking circuit of relay 57 has the resistance R included in it. This provision is made for the reason that if this resistance were not included in the locking circuit of relay 57, relay 56 might receive a direct ground impulse and energize. However, this is not possible with the resistance R in this circuit. By the operation of relay 57 a circuit is completed extending from ground on release trunk conductor 121 by way of armature 86 and its back contact, front contact and armature 102, back contact and armature 94, armature 119 and its back contact, and through the winding of the rotary magnet 126 to battery. Magnet 126 operates to rotate the switch wipers one step into engagement with the second trunk line of the group and at armature 110 breaks the locking circuit of the test relay 57 which deenergizes breaking the circuit of the rotary magnet 126 which deenergizes also. The slow acting relay 58 is energized in multiple with the rotary magnet and serves to maintain the test wiper 141 in connection with the test relays 56 and 57. Should this next trunk line be busy and provided it is not the last one of the group, ground potential will again be present on it through a resist-

ance of 500 ohms and the test relay 57 will be again energized to complete the rotary magnet circuit, which magnet will operate as before to rotate the switch wipers another step and to cause the deenergization of the test relay 57. This alternate operation of relay 57 and magnet 126 will continue until an idle trunk line is found or until the switch wipers are rotated into engagement with the last trunk line of the group. Should this trunk be busy also direct ground potential will be present on test contact engaged by the test wiper 141. Relays 56 and 57 will both be energized as in the first case described wherein the call was made with a straight or private line. Relay 56 upon operating, will establish a locking circuit for itself at armature 93, at armature 94 open the rotary magnet circuit, and at armature 95 place the busy tone on the calling subscriber's line.

However, should one of the trunk lines of the group be idle there will be no ground potential whatsoever present on this test contact and upon the switch wipers being rotated into engagement there will be no circuit for either of the test relays 56 and 57. Then following the deenergization of the slow acting relay 58 a circuit for the switching relays 59 and 60 will be completed. Should this trunk line not be the last one of the group the private normal conductor will of course have a resistance of 500 ohms on it. The relay 59 is so adjusted that it will not energize in series with the switching relay of the called line switch and 500 ohms resistance. The relay 60, however, operates over a circuit extending from ground on release trunk conductor 121 by way of armature 93 and its back contact, upper winding of relay 59, upper winding of the switching relay 60, back contact and armature 105, test wiper 141, test contact of the selected trunk line, private normal conductor through the 500 ohms resistance, winding of the switching relay and stepping magnet of the associated line switch to battery. Relay 60 and the switching relay of the line switch associated with the selected trunk line will energize over this circuit. Relay 60 upon operating, establishes a locking circuit for itself at armature 118, at armature 117 places ground through a resistance of 500 ohms on test wiper 141, and at armatures 115 and 120 completes the ringing circuit. It will be seen that this line has a ground potential on it through a resistance of 500 ohms and should another connector switch attempt to connect therewith, the relay similar to relay 57 will be operated and this switch will be caused to rotate into engagement with the next trunk line. Upon the operation of relay 60 ringing current is intermittently projected over the selected trunk line in the same manner as before described. When a response is

obtained from the operator ring cut off relay 55 is energized and the succeeding operations take place in identically the same manner as was hereinbefore fully explained.

5 Should however, the trunk line be the last one of a group and idle, then both switching relays 59 and 60 will be energized and direct ground potential will be placed in the test contact of the associated line by way
10 of the test wiper 141. Thus should another connector switch attempt to connect with this line both the relays similar to relays 56 and 57 in this switch will be energized and a busy tone transmitted to the
15 calling subscriber.

It will be seen from the above that this invention provides a rotary connector switch which accomplishes the same results with one test wiper as was formerly done
20 with two.

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

25 What I claim as my invention is:—

1. In a telephone system, a calling subscriber's line, an automatic switch associated therewith, a group of telephone lines having terminals in said switch, means controlled
30 by said calling subscriber for controlling said switch to connect with a line in said group, a pair of relays for said switch, a single test wiper, means for energizing one of said relays by way of said test wiper
35 when connection is made with one line in said group, and means for energizing the other of said relays by way of said test wiper when connection is made with another line in said group.

40 2. In a telephone system, lines of two classes, an automatic switch for connecting with said lines, test contacts for said lines, means in said switch effective when a line of one class is connected with for placing a
45 certain busy potential on the test contact thereof, and means in said switch effective in case a line in the other class is connected with for placing a different busy potential on the test contact thereof.

50 3. In a telephone system, lines of two classes, an automatic switch for connecting with said lines, test contacts for said lines, means in said switch effective when a line of one class is connected with for placing a
55 certain busy potential on the test contact thereof, means in said switch effective in case a line in the other class is connected with for placing a different busy potential on the test contact thereof, said means comprising two relays, and means for energizing one or both of said relays depending on
60 the class of line connected with.

4. In a telephone system, called telephone
65 line, an automatic switch having a test

wiper adapted to be connected with any one of said test contacts, a pair of relays in said switch each for applying a different busy potential to test contacts connected with, the second of said relays also having means for
70 applying ringing current to the called line, said second relay operative when the called line belongs to one class and both of said relays operative if the called line is of another class, means controlled by the first relay for making ineffective the busy potential
75 applied by said second relay so that the busy potential applied is dependent on the class of the line called.

5. In a telephone system, called lines of
80 two classes, an automatic switch having access to said lines, a pair of relays in said switch, means for energizing only one of said relays when connection is made with one of said lines to make that line busy, means
85 for energizing the other of said relays when connection is made with another of said lines, and means operated by said other relay for making ineffective the busy potential applied by said first relay.

6. In a telephone system, different kinds
90 of lines, a test contact for each one of said lines, an automatic switch for connecting with any one of said test contacts, and means in said switch effective when the switch is
95 connected with a test contact of one kind of line for applying a busy potential to its test contact, and means in said switch effective when the switch is connected with a test contact of another kind of line for applying a
100 busy potential of a different character.

7. In a connector having lines and test contacts accessible thereto, means for placing test potentials on the test contacts of
105 lines when the same are called and found idle, means in said switch for determining the values of applied test potentials, and testing means in said switch selectively responsive to such test potentials when lines are called and found busy, said potentials in
110 the second case being applied to the test contacts of the lines called by other connectors.

8. In a rotary connector, a test wiper, test contacts accessible to said connector having
115 two different test potentials on them, two relays in said connector connected to said test wiper in multiple when the same engages a test contact, both relays being responsive to one potential and only one relay being responsive to the other potential,
120 and automatic operating mechanism in said connector controlled jointly by said two relays.

9. In a rotary connector, a test wiper, test contacts accessible to said connector having
125 two different test potentials on them, two relays in said connector connected to said test wiper in multiple when the same engages a test contact, both relays being responsive to one potential and only one re-
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lay being responsive to the other potential, a motor magnet in said switch having a circuit closed by contacts on one of said relays, and contacts on the other of said relays for opening said circuit.

10. In a rotary connector, a test wiper, test contacts accessible to said wiper, two relays in said connector operable when said wiper is in engagement with a test contact, contacts on one relay for placing a certain potential on said wiper, and contacts on the other relay for placing a different potential on said wiper.

11. In a rotary connector, a test wiper, test contacts accessible to said wiper, two relays in said connector operable responsive to the engagement of said wiper with a test contact, a resistance, contacts on one relay for grounding said wiper through said resistance, and contacts on the other relay for short-circuiting said resistance.

12. In a telephone system, a plurality of lines, automatic switching mechanism for extending said lines when calling, an automatic switch for extending connections to said lines when the same are called, individual test contacts for said lines in the banks of said switch, means effective whenever any one of a certain plurality of said lines calls for connecting a source of test potential to the test contact individual to the calling line, and means effective whenever any other line calls for connecting a source of test potential to the test contact individual to the calling line over a different circuit, whereby different test potentials are present on said test contacts when the corresponding lines are tested, and testing means in said automatic switch selectively responsive to said test potentials.

13. In a telephone system, a plurality of lines, automatic switching mechanism for extending said lines when calling, an automatic switch for extending connections to said lines when the same are called, individual test contacts for said lines in the banks of said switch, means for placing direct ground on the test contact of any one of a plurality of lines when such line is calling, and means for grounding the test contact of any other of said lines through a resistance when the same is calling.

14. In a telephone system, individual and grouped lines, a cut-off relay individual to each line, a test contact individual to each line, a connection from each cut-off relay to the associated test contact, resistances in-

serted in said connections in the case of all the grouped lines except the last line of each group, and means effective when any line is calling for connecting a source of current to the associated test contact direct or through a resistance, depending on the kind of line calling, over a circuit excluding the associated cut-off relay.

15. In a telephone system, a rotary connector, groups of lines accessible to said connector, test contacts for said lines in the bank of said connector, cut-off relays for the last lines of the several groups connected direct to their associated test contacts, cut-off relays for the other lines of said groups connected to their associated test contacts through resistances, and contacts on each cut-off relay for connecting a source of test potential to the associated test contact, either direct or through the associated resistance, if one is present.

16. In a telephone system, called lines of two classes, an automatic switch for extending connections to any of said lines, a test contact for each one of said lines, means for placing a busy condition on the test contact of a line when a connection is extended thereto, and means in said switch for changing said busy condition providing said line is of a certain one of said classes.

17. In a telephone system, a group of lines, a cut-off relay for each of said lines, a test contact for each of said lines, a connection from each cut-off relay to the associated test contact, resistances inserted in said connections, means for energizing the cut-off relay of a line in series with its associated resistance when the line is called, and means for energizing the cut-off relay of a line independent of its associated resistance when the line is calling.

18. In a telephone system, two kinds of lines, test contacts for said lines, automatic switches for extending calls to or from said lines including connectors for extending connections to said lines, means for establishing distinctive busy conditions on said test contacts in accordance with the kind of line when said lines are busy, means associated with the lines for setting up the distinctive busy conditions if the lines are calling, and means in the connectors for setting up the distinctive busy conditions if the lines are being called.

Signed by me at Chicago, Illinois, this 15th day of January 1921.

JOHN E. GARDNER.