Aug. 14, 1928. 1,681,034

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AUTOMATIC TELEPHONE SYSTEM

Original Filed Aug. 12, 1921 2 Sheets-Sheet 1

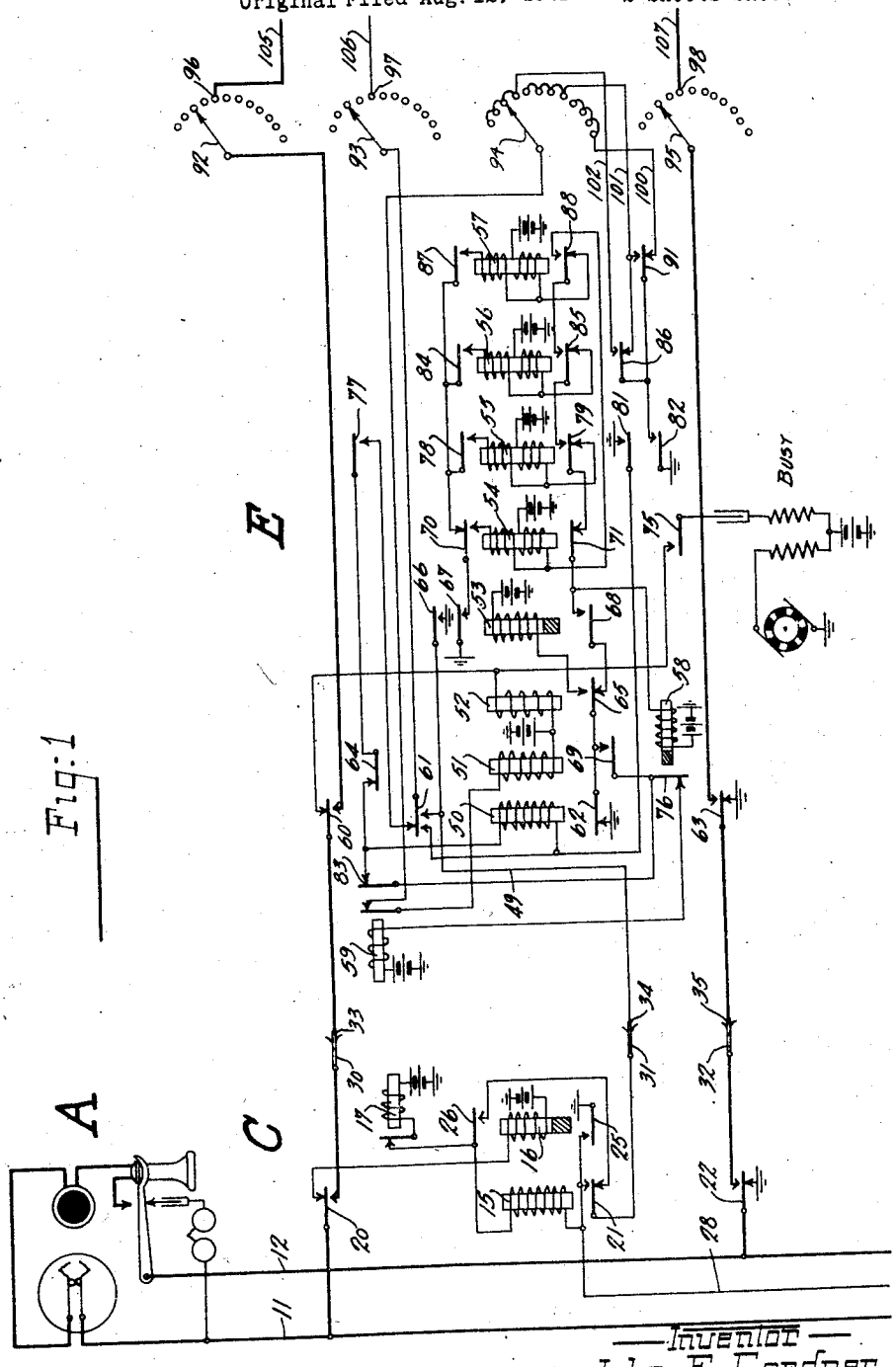

Fig. 1

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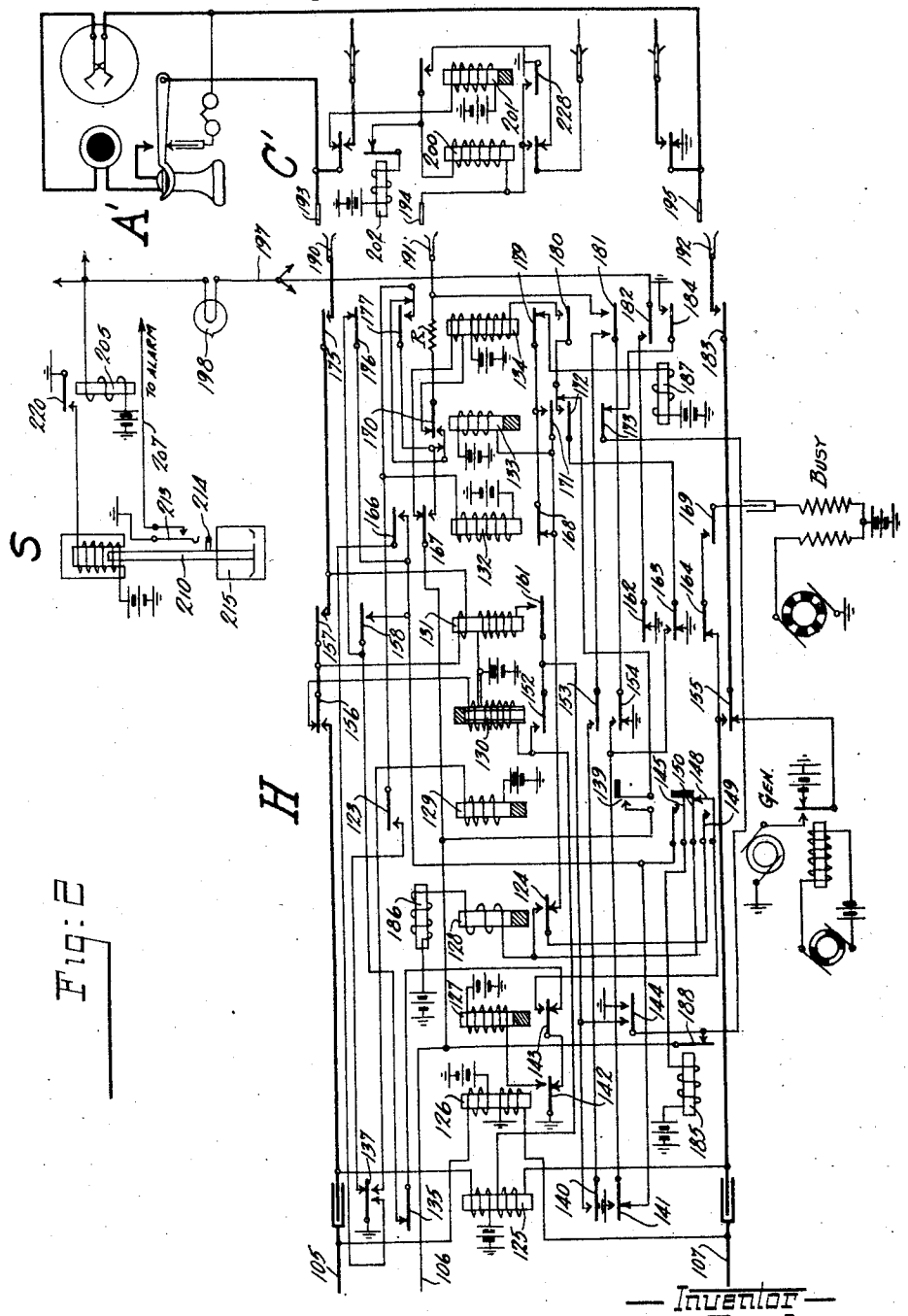

Fig. 2

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Patented Aug. 14, 1928. 1,681,034

UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Original application filed August 12, 1921, Serial No. 491,745. Divided and this application filed February 25, 1924. Serial No. 694,821. Renewed June 6, 1927.

The present invention relates in general to automatic telephone systems, and has for its principal object the provision of new and improved circuits for selector switches used in such systems whereby the operations of these switches are rendered more satisfactory. Certain features shown and described but not claimed in this application are being claimed in my pending application Serial No. 24,915, filed April 22, 1925.

One of the features of the invention relates to the provision of an improved selector switch which is of the same general mechanical construction as that of the well known rotary line switches. This selector, instead of being restored to normal after completion of each connection, maintains its wipers in engagement with the trunk line last used, and on the next call, should the same group be the one selected, the selector will not rotate unless the associated trunk is busy. If this trunk be busy, the selector will operate in the usual manner to select an idle trunk in the selected group. If the digit corresponding to another group of trunks is called, the switch operates to select an idle trunk in that group.

Another feature of this selector circuit is an arrangement whereby, if all the trunks in a group are busy, the selector will continuously test the trunks until one becomes idle whereupon the selector will immediately connect with it. Should the calling subscriber dial another digit while this testing operation is going on, the rotation of the switch will be stopped and a busy tone given to the calling subscriber.

There are other objects of the invention not now specifically mentioned which together with the foregoing will be described hereinafter reference being had to the accompanying drawings, in which Fig. 1 shows a calling station A, the individual line switch C, and the selector E, while Fig. 2 shows the connector H and a called station A^1.

In the drawings the invention has been shown applied to a small system of 300 lines capacity and therefore the selectors in the system need only have access to three groups of trunk lines leading to connector switches. It will, however, be evident that this system may be readily enlarged to any desired size by providing more bank contacts in the selectors of the system.

Referring now to the drawings, in Fig. 1 is shown a substation A of the usual automatic type, the associated line of which terminates at the exchange in individual line or trunk selecting switch C.

The line switch C is of the well known rotary type which does not restore to normal, but maintains its wipers in engagement with the trunk line last used. The line switch C in common with a plurality of other line switches has access to selector switches, one of these selectors being shown at E.

As before mentioned, the selector switches are similar in mechanical construction to the rotary line switches. However, these selectors have thirty contacts in their banks, instead of the usual twenty-five as have the ordinary line switches. These thirty contacts are then divided into three groups of ten contacts each, thus providing ten trunks in each group in accordance with the usual practice. The selector E has access to trunk lines terminating in connector switches in the various groups, one of these connectors being shown at H, Fig. 2.

The connector switch H is of the usual Strowger vertical and rotary type and has access to called subscribers' lines, one of these being shown at A^1.

The substation A^1 is similar to the substation A already described, and its associated line terminates at the exchange in the individual line switch C^1.

Having briefly described the apparatus shown in the drawings, a detailed explanation of its operation will now be given. For this purpose it will be assumed that the subscriber at substation A desires to call the subscriber at substation A^1. In order to do this, the subscriber at substation A will remove his receiver and operate his calling device in accordance with the three digits of the number which is assigned to the substation A^1. When the receiver is removed at the substation A, a circuit is completed for the line relay 16 of the individual line switch C over the line conductors 11 and 12 in series. Relay 16, upon energizing, at its armature 25 completes a

circuit which includes the switching relay 15 and the motor magnet 17 in series, and at its armature 26 connects the test wiper 31 to the above circuit at a point midway between the switching relay and the motor magnet. The operation of the line switch C now depends upon whether or not its wipers are associated with an idle trunk line. If the associated trunk line is busy, there will be a ground potential present upon the contact engaged by the test wiper 31, switching relay 15 will be short circuited, and the motor magnet 17, being supplied with direct ground via said test wiper, will operate as a buzzer to advance the switch wipers 30—32, inclusive, step by step until they are rotated into engagement with a set of bank contacts associated with an idle trunk line. However, in the present case it will be assumed that the trunk line with which the line switch wipers are associated when the receiver is removed at substation A is idle, and it will be assumed further that this trunk line is the one shown in the drawings terminating in bank contacts 33—35, inclusive. Under these conditions there will be no ground potential present upon the test contact 34 engaged by the test wiper 31, motor magnet 17 will not operate, and the switching relay 15, not being short circuited, will immediately energize in series with the said motor magnet. Relay 15, upon energizing, disconnects the line conductors 11 and 12 of the substation A from the winding of the line relay 16 and from ground, respectively, and extends them by way of armatures 20 and 22, wipers 30 and 32, bank contacts 33 and 35, to the winding of the line relay 52 of the selector E and to ground, respectively.

The line relay 52 is immediately energized over the calling subscriber's line loop and, upon operating, at armature 65 completes a circuit for the slow acting relay 53. The latter relay, upon energizing, at armature 68 prepares certain impulsing circuits in the selector E and at armature 66 places ground upon the release trunk conductor 49 thereby establishing a holding circuit for line switch C. This holding circuit extends from ground on release trunk conductor 49, test contact 34, test wiper 31, armature 21 and its front contact, through the winding of the switching relay 15, and thence through the winding of the motor magnet 17 to battery. It will be understood that the above traced holding circuit is completed before the slow acting line relay 16 has had time to deenergize. A branch of this holding circuit extends by way of the private normal conductor 28, 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 from intrusion in the usual manner.

The calling subscriber at substation A may now operate his calling device in accordance with the first digit of his desired number. By this operation a series of interruptions is produced in the circuit of the line relay 52 of the selector E which retracts its armature a corresponding number of times. At the first retraction of its armature 65 an impulse of current is sent over a circuit extending from ground by way of back contact and armature 62, armature 65 and its back contact, armature 68 and its front contact, armature 71 and its back contact, armature 79 and its back contact, and through the lower winding of the first counting relay 55 to battery. The lower winding of relay 55 is of high resistance and has a low number of turns; thus it is only strong enough to attract the armature 78 thereby completing a circuit which extends from ground by way of armature 67 and its front contact, armature 70 and its back contact, armature 78 and its front contact, through the upper and lower windings of relay 55 to battery. However, as long as the armature 65 of the line relay 52 is in a retracted position the upper winding of relay 55 is short circuited and the above traced circuit is ineffective. When the line relay attracts the armature 65, the two windings of the first counting relay 55 are immediately energized in series and all the armatures on the relay are operated. Relay 55, upon operating, at its armature 77 prepares a point in the testing circuit, at armature 79 transfers the impulsing lead to the second counting relay 56, at armature 81 prepares a point in the circuit of the switching relay 50, and at armature 82 places ground upon the conductors 100 and 101, whereby the second and third common sections of the bank corresponding to all the trunk lines in the second and third groups and adapted to be engaged by the wiper 94 are grounded. The slow acting relay 58 is energized in multiple with the counting relay 55 and at its armature 76 maintains the previously mentioned test circuit and also the circuit of the relay 50 open.

At this point it will be well to describe how the trunk lines accessible from the selector E are divided into groups. In this case it is necessary that the selectors have access to three groups of trunk lines. In addition to the usual line and test banks provided for switches of this rotary construction there is an extra set of bank contacts and an extra wiper to engage them. This extra set of bank contacts is divided into three groups of ten trunks each, all the contacts of each group being multiply connected. Thus it will be seen that as soon as ground is placed upon the conductors 100 and 101 all the contacts associated with the trunk lines in the second and third groups in this extra bank adapted to be engaged by the wiper 94

are grounded. The purpose of this will appear fully hereinafter.

Returning now to the operation of the line relay 52, upon the next retraction and attraction of its armature 65 the second counting relay 56 is energized in a manner similar to relay 55. Relay 56, upon energizing, at armature 85 extends the impulsing lead to the third counting relay, at armature 86 disconnects ground from the conductor 101 whereby ground is removed from all the contacts in the second group in the bank adapted to be engaged by wiper 94. At the front contact of armature 86, relay 56 places ground upon conductor 102 thereby grounding all the contacts associated with the first group of trunk lines in the contact bank adapted to be engaged by wiper 94. Assuming that digit 2 has been dialed by the calling subscriber, the line relay 52 will now maintain its armatures attracted. The slow acting relay 58 is maintained energized throughout the series of impulses which constitute the first digit of the desired number and shortly after the termination thereof deenergizes. It will be apparent that when ground is placed upon the various groups of contacts adapted to be engaged by the wiper 94, as the switch wipers have no normal position, the said wiper will be grounded. The stepping relay 51 is thereby energized and, upon operating, at armature 69 prepares a point in the circuit of the rotary magnet 59, and at armature 64 opens a point in the testing circuit of test wiper 93. If the switch wipers are standing in a group other than that which is called by the calling subscriber, there will be a ground potential present upon the contact engaged by the wiper 94, and the stepping relay 51 will be energized as previously mentioned. Then, relay 58, upon deenergizing, at its armature 76 completes the circuit of the motor magnet 59. Magnet 59 operates to rotate the switch wipers into engagement with the next set of bank contacts, thus opening the circuit of the stepping relay 51. As the switch wipers have been assumed to be standing in a group other than that desired, there will be a ground potential upon this test contact, provided, of course, that the switch wipers have not been rotated into engagement with the trunk lines of the second group, and stepping relay 51 will be again energized to complete the circuit of the rotary magnet 59. The alternate operation of the stepping relay 51 and the rotary magnet 59 will continue until the switch wipers are rotated into selective relation with the group of trunks which terminate in the connector switches that have access to the desired subscriber's line. As the digit 2 was dialed by a calling subscriber, the first and third groups of bank contacts adapted to be engaged by the test wiper 94 will be grounded and the switch wipers will be rotated by the operation of the stepping relay 51 until they are brought into selective relation with the first trunk line in the second group. This second group of bank contacts adapted to be engaged by the test wiper 94 will not be grounded; there will be no circuit completed for the stepping relay 51; and the test wiper 93 will now come into operation. If the first trunk line in the second group is busy, there will be a ground potential present upon the test contact engaged by the test wiper 93, and a circuit will be completed which extends from the said grounded test contact by way of test wiper 93, armature 61 and its back contact, front contact and armature 77, armature 64 and its back contact, back contact and armature 83, armature 76 and its back contact, and thence through the winding of the motor magnet 59 to battery. The motor magnet 59 is thereupon operated to advance the switch wipers into engagement with the next set of bank contacts in the selected group and at the same time breaking its own circuit at armature 83. If this next trunk line is busy, the associated test contact will be grounded and the motor magnet 59 will operate as before. The operation of magnet 59 will continue until the switch wipers are rotated into engagement with an idle trunk line. However, it will be assumed in the present case that the first trunk line in the second group is idle, and it will be assumed further that this is the trunk line shown in the drawings and terminating in bank contacts 96—98, inclusive. It will be noted that the switching relay 50, whose circuit is completed by the deenergization of slow acting relay 58, is short circuited by ground from the various test contacts during the trunk selecting operation of the switch. When this idle trunk is found, there will be no ground potential present upon the test contact 97. Accordingly, motor magnet 59 is not operated, and the switching relay 50 being no longer short circuited is immediately energized in series with the said motor magnet. Relay 50, upon energizing, at armature 62 disconnects ground from the front contact of armature 69 and opens the circuit of the slow acting relay 53, at armature 61 opens the testing circuit, at the front contact of this armature closes a locking circuit for itself, and for switching relay 15 of the line switch C, and at armatures 60 and 63 disconnects the incoming trunk conductors from the winding of the line relay 52 and from ground, respectively, and extends them by way of the said armatures, wipers 92 and 95, bank contacts 96 and 98, trunk conductors 105 and 107, and thence through the upper and lower windings of the line relay 126 of the connector H.

Line relay 126 is immediately energized

over the calling subscriber's line loop and, upon operating, at its armature 142 completes the circuit of the slow acting relay 127. The latter relay, upon energizing, at armature 143 prepares the operating circuits of the connector H and at armature 144 places ground upon the release trunk conductor 106 thereby completing a holding circuit for switching relays 50 and 15. This holding circuit extends from ground on release trunk conductor 106, test contact 97, test wiper 93, armature 61 and its front contacts, through the winding of the switching relay 50, back contact and armature 83, armature 76 and its back contact, and thence through the winding of the motor magnet 59 to battery. A branch of this holding circuit joins the previously traced holding circuit of the line switch C. It will be understood that the above traced holding circuit is completed before the slow acting relay 53 has had time to deenergize. It will be seen that relay 53, upon deenergizing, opens the locking circuits of the various counting relays which have been energized in response to the digits sent by the calling subscriber, and these relays then deenergize to remove ground from the various groups of contacts in the bank adapted to be engaged by the wiper 94 and to restore certain other circuits in the selector E to normal.

The calling subscriber may now operate his calling device in accordance with the second digit of the desired number. By this operation a series of interruptions is produced in the circuit of the line relay 126 of the connector H, and this relay deenergizes a plurality of times in response thereto. At the first retraction of its armature a circuit is completed which extends from ground by way of armature 142 and its back contact, armature 143 and its front contact, off normal springs 148 and 150, through the winding of the low resistance slow acting relay 128, and thence through the winding of the stepping magnet 186 to battery. The above is the circuit over which the first vertical impulse is transmitted. However, upon the first vertical step of the shaft, the off normal springs are shifted and the remaining impulses to the vertical magnet traverse a new circuit which is the same as the one previously traced except that it includes the off normal springs 148 and 149 and armature 124 and its front contact, relay 128 being now in a operated position. The vertical magnet 186 operates to raise the switch wipers 190–192, inclusive, step by step until they are placed opposite the desired level of bank contacts in which is located the contact set associated with the substation A^1. The slow acting relay 128 is energized in series with the vertical magnet and maintains its armature attracted throughout the vertical movement of the switch and, at the termination thereof, deenergizes and transfers the impulsing circuit to the rotary magnet 187.

The calling subscriber may now operate his calling device in accordance with the third and final digit of his desired number. As before, a series of interruptions is produced in the circuit of the line relay 126 which retracts its armature a corresponding number of times. At each retraction of its armature 142 an impulse of current is sent over the following circuit: ground, armature 142 and its back contact, armature 143 and its front contact, off normal springs 148 and 149, armature 124 and its back contact, back contact and armature 168, armature 179 and its back contact, and thence through the winding of the rotary magnet 187 to battery. Magnet 187 operates to rotate the switch wipers into engagement with the set of bank contacts associated with the desired line which, we will assume, are the bank contacts 193–195, inclusive, in which is terminated the line of the subscriber A^1. The slow acting relay 133 is energized in multiple with the rotary magnet and operates at its armature 170 to connect the test wiper 191 to the test relay 132.

Assuming that the desired line is busy at the present time, there will be a ground potential present upon the test contact 194, and a circuit will be completed extending from the said grounded test contact, test wiper 191, resistance R, armature 170 and its front contact, normally closed springs controlled by armature 177, and thence through the winding of the test relay 132 to battery. Relay 132, upon energizing, prepares a point in its locking circuit at armature 167 which is completed immediately upon the deenergization of the slow acting relay 133, and at armature 169 places a busy tone upon the lower heavy talking conductor. In this manner the usual audible signal is returned to the calling subscriber in order to inform him that the desired line is busy. He will replace his receiver thereby releasing the operated switches in a manner which will be described hereinafter.

It will now be assumed that when the switch wipers 190–192, inclusive, of the connector H are rotated into engagement with the bank contacts 193–195, inclusive, the line of the substation A^1 is idle. Under these conditions there will be no ground potential present upon the test contact engaged by the test wiper 191 and there will be no circuit completed for the test relay 132. Then, immediately following the deenergization of the slow acting relay 133, a circuit is completed which extends from ground on release trunk conductor 106, armature 167 and its back contact, upper winding of switching relay 134, back contact and armature 170, resistance R, test wiper 191, test contact 194,

through the winding of the cut-off relay 200 of the line switch C^1 and thence through the winding of the motor magnet 202 to battery. The switching relay 134 and the cut-off relay 200 are energized over this circuit. However, due to a mechanical interlocking device controlled by the armature of the line relay 201 which is now at normal, the relay 200 only partially attracts its armatures, that is, enough to disconnect the line of the substation A^1 from its normal battery and ground connections in the line switch C^1

In the connector H, relay 134, upon operating, establishes a locking circuit for itself to ground on release trunk conductor 106 at armature 180, at armature 181 places direct ground upon the test wiper 191, at armature 177 opens the testing circuit of the test relay 132, at armature 176 opens a point in the circuit of the release magnet, at armature 184 places an additional ground upon the release trunk conductor 106, and at armatures 175 and 183 completes the ringing circuit. Ringing current is now intermittently projected out on the called line until the subscriber at substation A^1 answers. Another result of the energization of relay 134 is that a circuit is completed which extends from ground by way of back contact and armature 162, front contact and armature 182, conductor 197, through the lamp 198, and thence through the winding of relay 205 to battery. Relay 205 is energized over this circuit and, upon operating, at its armature 220 closes the circuit of the solenoid S. If the ringing circuit is completed for the substation A^1 the ring-up relay 131 will be immediately energized. Relay 131, upon operating, establishes a locking circuit for itself at armature 161, at armature 162 opens the previously traced circuit of the relay 205, at armature 158 closes a point in the release circuit, and at armature 157 short circuits its upper winding.

If for any reason the called line were open, the ring-up relay 131 would not be energized and the circuit of the relay 205 would be maintained closed. As was mentioned previously, the relay 205, upon operating, closes the circuit of the solenoid S. The solenoid S, upon energizing, immediately begins to pull up its plunger 210. The plunger arm 210 is not completely operated for a considerable time on account of the dash pot 215 which, though it does not allow the plunger 210 to pull up quickly, does not retard its restoration. However, as the relay 131 in the connector switch is not operated, the circuit of the relay 205 will be maintained closed and the solenoid S will finally pull the plunger 210 into its operated position thereby causing the cam 214 thereon to force the spring 213 into engagement with its working contact. Ground is thereby placed on the conductor 207 and a signal is given to the attendant. It should be mentioned at this point that the lamp 198 is common to a group of connector switches which have access to a group of called lines and lights in series with the relay 205. The attendant, upon hearing the alarm, will look to see what lamp such as 198, is lighted in order to determine in what group the connector switch giving trouble is located. The attendant will be able to ascertain what connector switch is in trouble by listening in on the operated connector switches and after finding the connector in trouble, he will inform the calling subscriber to call the desired number at some later time.

When the calling subscriber replaces his receiver, which may occur shortly after the operation of the connector switch, as he will hear no ringing induction or in compliance with the request of the attendant, the line relay 126 deenergizes and opens the circuit of the slow acting relay 127. After the deenergization of the line relay 126 and before the deenergization of the slow acting relay 127, an impulse of current is sent to the slow acting relay 133. Relay 133 energizes at this time and removes one ground from the release trunk conductor 106 at armature 170 and at armature 173, and at armature 172 transfers the locking circuit of the relay 134 from the release trunk 106 to grounded armature 163. Upon the deenergization of the slow acting relay 127 ground is removed from the release trunk conductor 106. The conductor switch is not released at this time as the release magnet circuit is opened at armature 176. When ground is removed from release trunk conductor 106 the holding circuit for the switching relay 50 of the selector E and relay 15 of the line switch C is opened and these relays deenergize. It will be noted that the wipers of the selector switch are maintained in engagement with the contacts 96-98, inclusive, which are the bank contacts associated with the trunk line last used and that these same wipers of the selector E have no normal position. The deenergization of relay 50 serves to restore the circuits of the selector E to normal. Relay 15, in the line switch C, upon deenergizing, again connects the line conductors of the substation A to the winding of the line relay 16 and to ground.

Returning now to the operation of the connector switch H, when the slow acting relay 127 deenergizes, the circuit of the slow acting relay 133 is opened. Relay 133, upon deenergizing, at armature 173 again connects ground to the release trunk conductor 106 over the following circuit: ground by way of front contact and armature 184, back contact and armature 173 back contact and

armature 188, to release trunk conductor 106. Another result of the deenergization of relay 133 is that the locking circuit of the switching relay 134 is transferred to the release trunk conductor 106 at the normally closed springs controlled by armature 172. The replacement of ground upon release trunk conductor 106 serves to prevent the connector switch H from being seized and used in another call. When the attendant has cleared the trouble he will operate the armature of the release magnet thereby restoring the switch shaft to normal. The springs 139 are a kind of off normal springs but they are adapted to be controlled directly by the vertical and release magnets; that is, as soon as the vertical magnet operates, the spring 139 engages its working contact and as soon as the armature of the release magnet is operated, the spring 139 disengages its working contact. This spring 139, may be mounted on the double dog of any Strowger switch. By the operation of spring 139 the locking circuit of the relay 134 is opened, and this relay deenergizes, thus restoring the circuits of the connector H to normal, at the same time removing ground from the release trunk conductor 106 and again rendering the connector H accessible to the selector switches. Another result of the deenergization of relay 134 is that the circuit of relay 205 is opened, and this relay deenergizes, opening the circuit of the solenoid S which immediately restores to normal, as the dash pot 215 has no appreciable effect upon the downward operation of the plunger 210.

The above described operations take place and an alarm signal is given to the attendant under various conditions, some of which will be briefly pointed out. In case the generator lead is open, the relay 131 will not energize and the attendant will be signalled as before described. If the line wipers of the connector H are open, or out of alignment, or if the line wiper cords are open, the relay 131 will not energize and the attendant will be signalled. This also happens in case the private wiper is out of alignment with the line wipers far enough so that when the switch is operated the private wiper and the line wipers become associated with different lines. That is, the private wiper may be incorrectly positioned on the shaft so that it stands a step ahead or one or more steps behind the line wipers. In this case the cut-off relay 200 in the called line switch, the one engaged by the line wipers, is not operated and the ringing circuit is short circuited by the ground connection in the line switch. It will be seen that there are a number of other times when this alarm will be given to the attendant, such as when the called line is grounded outside the central office, and so on. However, as these conditions are perfectly obvious they will not be mentioned.

Should the calling subscriber replace his receiver before the connector H has established connection with the desired line, the line relay 126 will be deenergized and operate to open the circuit of the slow acting relay 127. The latter relay, upon deenergizing, removes ground from the release trunk conductor 106 and also closes the release magnet circuit over a path extending from ground by way of armature 142 and its back contact, armature 143 and its back contact, armature 135 and its back contact, back contact and armature 176, working contact of off normal spring 145 and said spring, and thence through the winding of the release magnet 185 to battery.

It will now be assumed that the connection was completely established and that the line of the substation A^1 was not in trouble. Under these conditions the relay 131 will be energized and operate in the same manner as was before described. When the called subscriber answers, the ring cut-off relay 130 will be energized over the called subscriber's line loop. Relay 130, upon operating, at armature 152 establishes a locking circuit for itself, at armature 154 removes the direct ground connection from the private wiper 191, at armatures 156 and 155 opens the ringing circuit, and at the front contacts of these armatures finally completes the talking connection. The back bridge relay 125 is immediately energized over the called line and, upon operating, at armature 137 closes the circuit of the slow acting relay 129, at armature 135 opens a point in the circuit of the release magnet, and at armature 141 again places direct ground upon the test wiper 191. During the interval that direct ground is removed from the test wiper 191, the cut-off relay 200 in the line switch C^1 is maintained operated, and the called line protected over a circuit extending from ground on release trunk conductor 106, armature 167 and its back contact, upper winding of the switching relay 134, back contact and armature 170, resistance R, test wiper 191, test contact 194, through the winding of the cut-off relay 200, and thence through the winding of the motor magnet 202 to battery. During the interval between the energization of relay 130 and the energization of relay 125, a circuit in multiple with that of the cut-off relay 200 may be traced extending from ground on release trunk conductor 106, armature 167 and its back contact, upper winding of the switching relay 134, back contact and armature 170, resistance R, front contact and armature 181, armature 154 and its front contact, armature 141 and its back contact, working contact of off normal spring 145 and the said spring, and thence through the release magnet 185 to battery. Owing to the combined resistance of the upper

winding of the switching relay 134 and the resistance R, the release magnet 185 does not operate at this time. The connection has now been completed and conversation may take place between the calling subscriber and called subscriber, talking battery being supplied to the calling subscriber from the windings of the line relay 126 and to the called subscriber from the windings of the back bridge relay 125.

When the conversation is terminated, both subscribers will replace their receivers. In order to describe this releasing operation, it will first be assumed that the calling subscriber replaces his receiver before the called subscriber. When the receiver is replaced at the calling substation, the circuit of the line relay 126 is opened, and this relay deenergizes thereby opening the circuit of the slow acting relay 127. After the deenergization of the line relay 126 and before the deenergization of the slow acting relay 127, an impulse of current is sent to the slow acting relay 133. Ground is thus momentarily removed from the release trunk conductor 106 as before described, but the release of the connector H does not take place as the circuit of the release magnet is opened at armature 135. The selector E and the line switch C are released in the same manner as was previously described upon ground being removed from the release trunk 106. When the called subscriber finally hangs up, the circuit of the slow acting relay 129 is opened, ground is removed from the test wiper 191 and the circuit of the release magnet 185 is completed. This circuit extends from ground by way of armature 142 and its back contact, armature 143 and its back contact, back contact and armature 135, armature 158 and its front contact, working contact of off normal spring 145 and the said spring, and thence through the release magnet 185 to battery. It will be noted that after the deenergization of relay 125 and prior to the deenergization of relay 129, an impulse of current is sent to the test relay 132. The operation of relay 132 serves no particular function at this time. Other results of the deenergization of relay 125 are that the locking circuits of the relays 130 and 131 are opened, and these relays deenergize. The operation of the spring 139 controlled by the release magnet serves to open the locking circuit of the relay 134. In this manner all the apparatus is released.

It will now be assumed that the called subscriber replaces his receiver before the calling subscriber. When the receiver is replaced at substation A^1, the circuit of the back bridge relay 125 is opened, and this relay deenergizes. Upon deenergizing, relay 125, at armature 137 opens the circuit of the slow acting relay 129, and before the deenergization of this latter relay, sends an impulse of current to the test relay 132. The latter relay, upon energizing, removes one ground connection from the test wiper 191 at armature 167, at the front contact of this armature establishes a locking circuit for itself, and at armature 166 prepares a point in the release magnet circuit. Another result of the deenergization of relay 125 is that at armature 141 ground is removed from the test wiper 191, and at the back contact of this armature a circuit is prepared for the release magnet 185. When ground is removed from the test wiper 191, the cut-off relay 200 in the line switch C^1 deenergizes and again connects the line of the substation A^1 to the winding of the line relay 201 and to ground. Now when the calling subscriber hangs up, the release of the connection will take place in a manner similar to that already described.

However, should the calling subscriber maintain his receiver off the hook, and the subscriber at substation A^1 desire to make a call, the latter subscriber will remove his receiver and operate his calling device in the usual manner. When the receiver is removed at substation A^1, a circuit is completed for the line relay 201 of the line switch C^1 in multiple with the back bridge relay 125 of the connector H. Relay 125, upon energizing, at armature 137 completes a circuit which extends from ground by way of the said armature and its front contact, armature 166 and its front contact, working contact of off normal spring 145 and the said spring, and thence through the winding of release magnet 185 to battery. Magnet 185 operates to restore the connector H to normal. Another result of the operation of this magnet is that at armature 188 ground is removed from the release trunk conductor 106, and the holding circuit of the switching relay 50 in the selector E and the relay 15 in the line switch C is opened. The selector E and line switch C are restored to normal in the same manner as was previously described. In the connector H, since ground is removed from release trunk conductor 106, the locking circuits of the relays 132 and 134 are opened. Relay 134 deenergizes and restores certain circuits in the connector H to normal and disconnects the switch wipers from their connections in the connector H. Immediately upon the deenergization of the relay 15 in the line switch C, the line relay 16 is again energized and the line switch operates in the usual manner to select an idle trunk extending to a selector switch which in this case is the selector E. When the calling subscriber's line is extended to the selector E, a circuit is completed for the line relay 52 thereof which immediately energizes to close the circuit of the slow acting release relay 53. The latter relay energizes

and completes the holding circuit of the switching relay 15 in the line switch. When the calling subscriber hangs up, the line switch C and the selector E are released in the usual manner. Immediately upon the deenergization of the switching relay 50 of the selector E, the circuit of the line relay 126 in the connector H is opened, and this relay deenergizes to break the circuit of the slow acting relay 127. Upon the deenergization of relay 126 and before relay 127 deenergizes, an impulse of current is sent to the slow acting relay 133 which operates to maintain ground removed from the release trunk conductor 106 for a short interval. Upon the deenergization of slow acting relay 127, the circuit of the slow acting relay 133 is opened and also the locking circuits of the relays 130 and 131 are opened. Immediately upon the deenergization of the relay 134, the circuit of the back bridge relay 125 is opened, and this relay deenergizes, thus opening the circuit of the slow acting relay 129 and sending an impulse of current to relay 132. The operation of relay 132 serves to maintain the circuit of the rotary magnet open so that it does not receive an impulse of current upon the deenergization of the line relay 126. Another result of the deenergization of the slow acting relay 127 is that a new circuit for the release magnet is completed which extends from ground by way of armature 142 and its back contact, armature 143 and its back contact, armature 135 and its back contact, back contact and armature 176, working contact of off normal spring 145 and the said spring, and through the winding of the release magnet 185 to battery. In this manner all the apparatus in the connector H is restored to normal. It will be remembered that when the selector E and line switch C were released by the removal of ground from the release trunk conductor 106, the line switch C immediately operated to again connect with the selector E whereby this selector is rendered busy. In the present system, the release of the selector E serves to free the connector H so this connector may be used again.

The above operations take place when the calling subscriber persists in holding his receiver off the switchhook after the conversation is terminated with the called party and that called party desires to establish a connection for himself. The operation of the system, when another connection is desired with the called line by another subscriber while the connector H is still in engagement with that line, will now be described. As will be remembered, the connector H is standing in operative connection with the bank contacts 193–195, inclusive, of the called line. However, there is no ground potential present upon the test contact 194, and another connector similar to H may establish connection with this line. Upon so doing, ground is placed upon a multiple test contact accessible to the other connector switch, and this ground then completes a circuit which extends by way of the test contact 194, test wiper 191, front contact and armature 181, armature 154 and its front contact, armature 141 and its back contact, working contact of off normal spring 145 and the said spring, and through the winding of the release magnet 185 to battery. Magnet 185 operates to restore the connector H to normal and removes ground from the release trunk conductor 106. The latter operation causes the release of the selector E and the line switch C in the same manner as was described above. In the connector H the various relays are restored to normal in a manner similar to that already described.

As was previously mentioned, the selector E is adapted, if all the trunks in the selected groups are busy, to continuously test these trunks and to connect with one as soon as it becomes idle. In order to describe this operation it will be assumed that the second group of trunks is the one selected and that all these trunks are busy. As all the trunks in this group are busy, there will be a ground potential present upon all the test contacts in this group engaged by the test wiper 93, and the motor magnet 59 of the selector E will continue to operate. When the switch wipers are rotated into the third or first groups the contacts engaged by the wiper 94 having been grounded by the operation of the counting relays 55 and 56, the stepping relay 51 will operate to close a circuit of the motor magnet. In this manner the selector E will continue to test by means of the wiper 93 for an idle trunk in the second group. As soon as the trunk in the second group becomes idle, there will be no ground potential upon its associated test contact and the selector E will connect with it and the connection will proceed in the usual manner.

Should the calling subscriber dial another digit before the selector E has connected with an idle trunk, the fourth and last counting relay 54 is immediately energied upon the second retraction and attraction of the armature 65 of the line relay 52. Relay 54, upon operating, at armature 70 opens the locking circuits of the counting relays 55, 56 and 57, at the front contact of this armature establishes a clocking circuit for itself, at armature 71 opens the impulsing circuits, and at armature 75 places the busy tone from the busy machine on the upper heavy talking conductor. By this latter operation the calling subscriber is notified that he must hang up his receiver and call his number over again. It will be

seen that this arrangement prevents the possibility of the calling subscriber obtaining a wrong number or not receiving any indication that he has not been able to obtain his connection.

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

What I claim as my invention is:

1. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible thereto, wipers for said switch normally in electrical engagement with the trunk line used in the previously established connection, and means for causing said switch to advance said wipers in response to a digit of a called number to select a particular one of said groups.

2. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible thereto, said switch being responsive to a digit of a called number to select a particular group, terminals for said trunk lines, and a pair of line wipers for said switch having access to all said trunk lines and always in electrical engagement with the terminals of some one of said trunk lines which connected trunk line is always the one last employed by said switch for extending a call.

3. In a telephone system, a calling line, an automatic switch, trunk lines divided into groups accessible thereto, said switch normally standing in selective relation to one of said trunks, means controlled from a calling line for causing both group and trunk selecting movements of said switch in response to a digit of a called number to select one of said trunks, both group and trunk selecting movement of said switch being omitted, however, if said switch is already associated with an idle trunk line in the proper group.

4. In a telephone system, a calling line, an automatic switch, trunks divided into groups accessible thereto, said switch normally standing in selective relation to one of said trunks, means controlled from a calling line for causing both group and trunk selecting movements of said switch in response to a digit of a called number to select one of said trunks, both group and trunk selecting movements of said switch being omitted, however, if said switch is already associated with an idle trunk in the proper group.

5. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible thereto, said switch having a rotary movement only to select groups and an idle trunk in a group, means for seizing said trunk line and for operating said switch into selective relation with regard to one of said groups, automatic means for then causing said switch to select an idle trunk in the selected group, and means operative when all the trunk lines in the selected group are busy for causing said switch to continuously test the trunk lines in the group selected.

6. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible thereto, said switch having a rotary movement only to select groups and an idle trunk in a group, means for seizing said trunk line and for operating said switch into selective relation with regard to one of said groups, automatic means for then causing said switch to select an idle trunk in the selected group, means operative when all the trunk lines in the selected group are busy for causing said switch to continuously test the trunk lines in the group selected, and means operative when one of said trunk lines becomes idle for causing said switch to connect therewith.

7. In a telephone system, a trunk line terminating in an automatic switch, groups of trunk lines accessible thereto, a series of counting relays in said switch, a motor magnet therefor, means for seizing said trunk line and for sending impulses thereover to energize said counting relays successively, means controlled by the last energized relay for causing the operation of said motor magnet to bring said switch into selective relation with one of said groups of trunk lines, and automatic means for then causing said switch to select an idle trunk line in the selected group.

8. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible to said switch, an operating magnet for said switch, counting relays in said switch corresponding in number to the number of groups of said trunk lines, means for sending impulses over said first trunk line to energize one of said counting relays, said magnet being non-responsive to said impulses, means responsive to such energization for causing said magnet to operate said switch into selective relation with the group corresponding to the relay energized, and automatic means for causing said switch to select an idle trunk line in the selected group.

9. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible to said switch, an operating magnet for said switch, a circuit for said operating magnet including a test wiper of said switch, bank contacts adapted to be engaged by said test wiper, a group of counting relays in said switch, means for sending impluses over said trunk line to energize a particular one of said relays and for disabling said magnet during the sending of impulses, means controlled by

said relay for altering the potential on said bank contacts, whereby said switch is operated by said magnet into selective relation with a certain particular group of said trunks under control of said test wiper, and automatic means for causing said switch to select an idle trunk line in the selected group.

10. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible to said switch, an operating magnet for said switch, a circuit for said operating magnet including a test wiper of said switch, bank contacts adapted to be engaged by said test wiper, a group of counting relays in said switch, means for sending impulses over said trunk line to energize a particular one of said relays, means for maintaining said circuit open until said impulses have been sent, means controlled by said relay for altering the potential on said bank contacts, whereby said switch is operated by said magnet into selective relation with a certain particular group of said trunk lines under control of said test wiper, a second test wiper for said switch and means controlled by said second test wiper for causing said switch to select an idle trunk in the selected group.

11. In a telephone system, a trunk line terminating in an automatic switch, trunk lines divided into groups accessible to said switch, an operating magnet for said switch, two circuits for said magnet each including a test wiper of said switch, bank contacts adapted to be engaged by said test wipers, a group of counting relays in said switch, means for sending impulses over said trunk line to energize a particular one of said relays, means controlled by said relay for altering the potential on said bank contacts whereby said switch is brought into selective relation with a certain group of said trunk lines by one of said test wipers controlling said motor magnet, and automatic means controlled by the other of said test wipers for causing said switch to select an idle trunk in the selected group.

12. In an automatic switch, counting relays, test contacts normally free from any test potential, contacts on the first counting relay for placing a test potential on all but the first test contact, and contacts on the second counting relay for transferring said test potential from the second test contact to the first test contact.

13. In an automatic switch, counting relays, test contacts normally free from any test potential, contacts on the first counting relay for placing a test potential on all but the first test contact, contacts on the second counting relay for transferring said test potential from the second test contact to the first test contact, and contacts on the third counting relay for transferring said test potential from the third test contact to the second test contact.

In witness whereof, I hereunto subscribe my name this 13th day of February, A. D., 1924.

JOHN E. GARDNER.