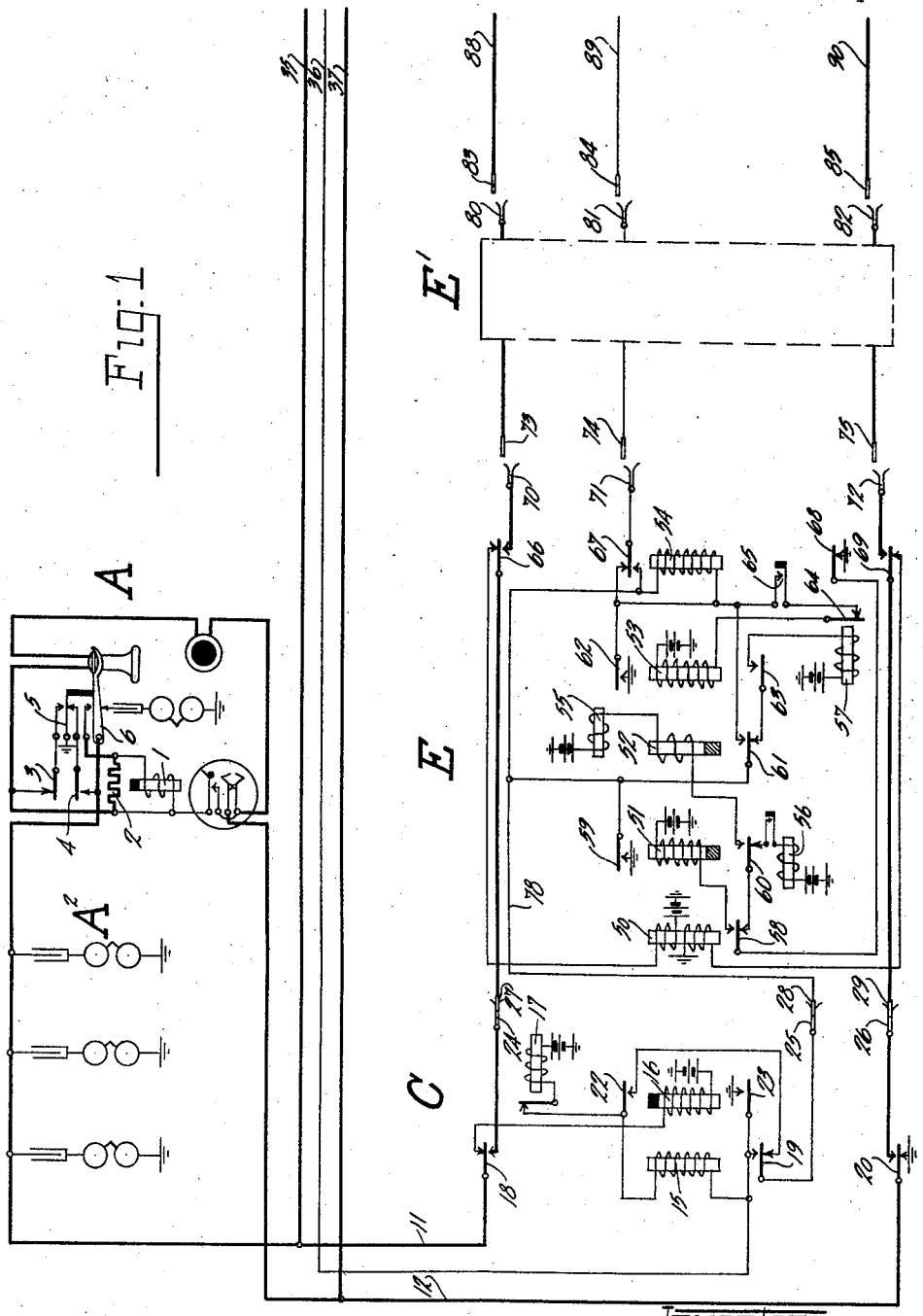
Dec. 14, 1926. 1,610,438

J. E. GARDNER ET AL

AUTOMATIC TELEPHONE SYSTEM

Filed Oct. 9, 1922 3 Sheets-Sheet 1

Fig. 1



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AUTOMATIC TELEPHONE SYSTEM

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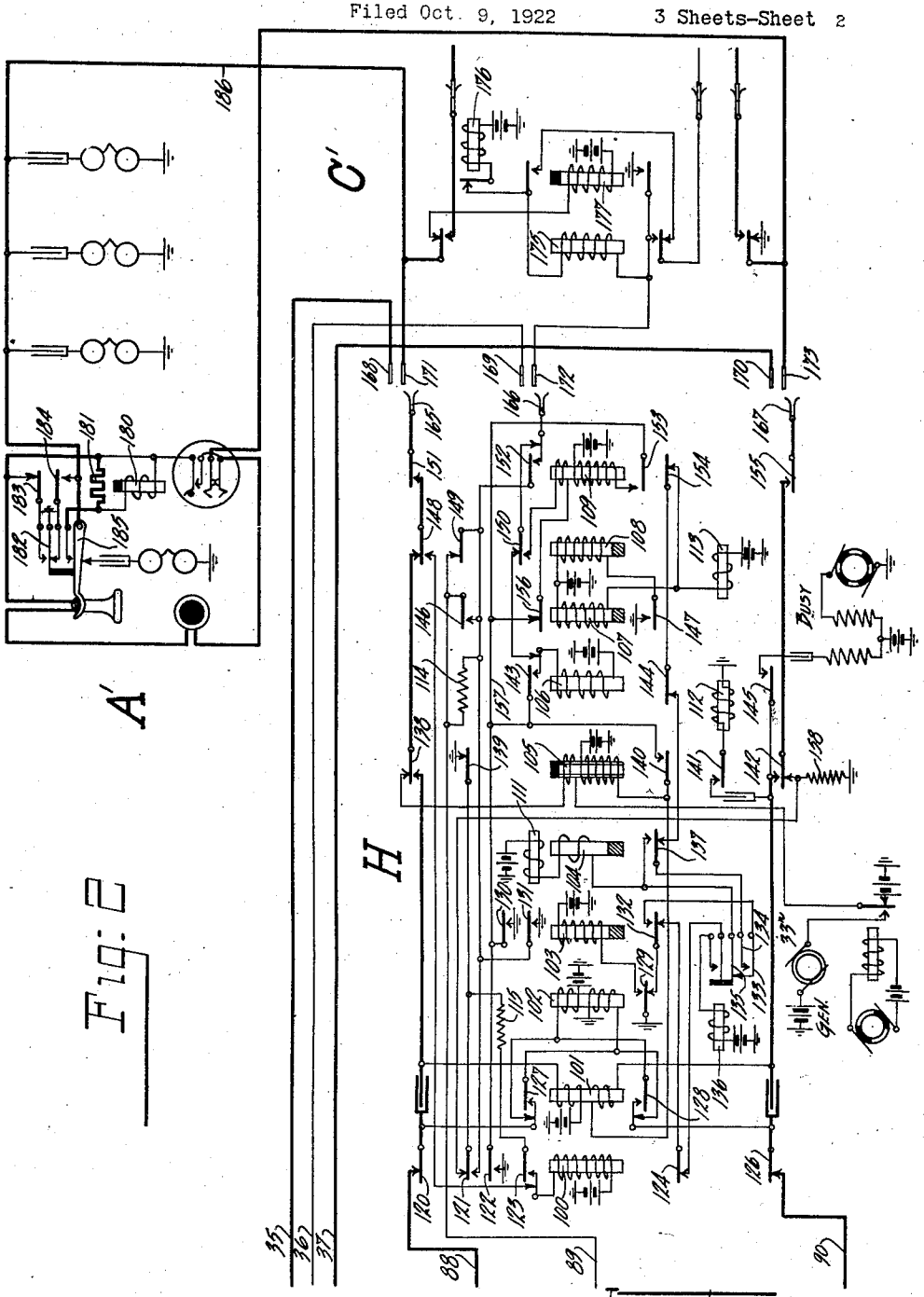


Fig. 2

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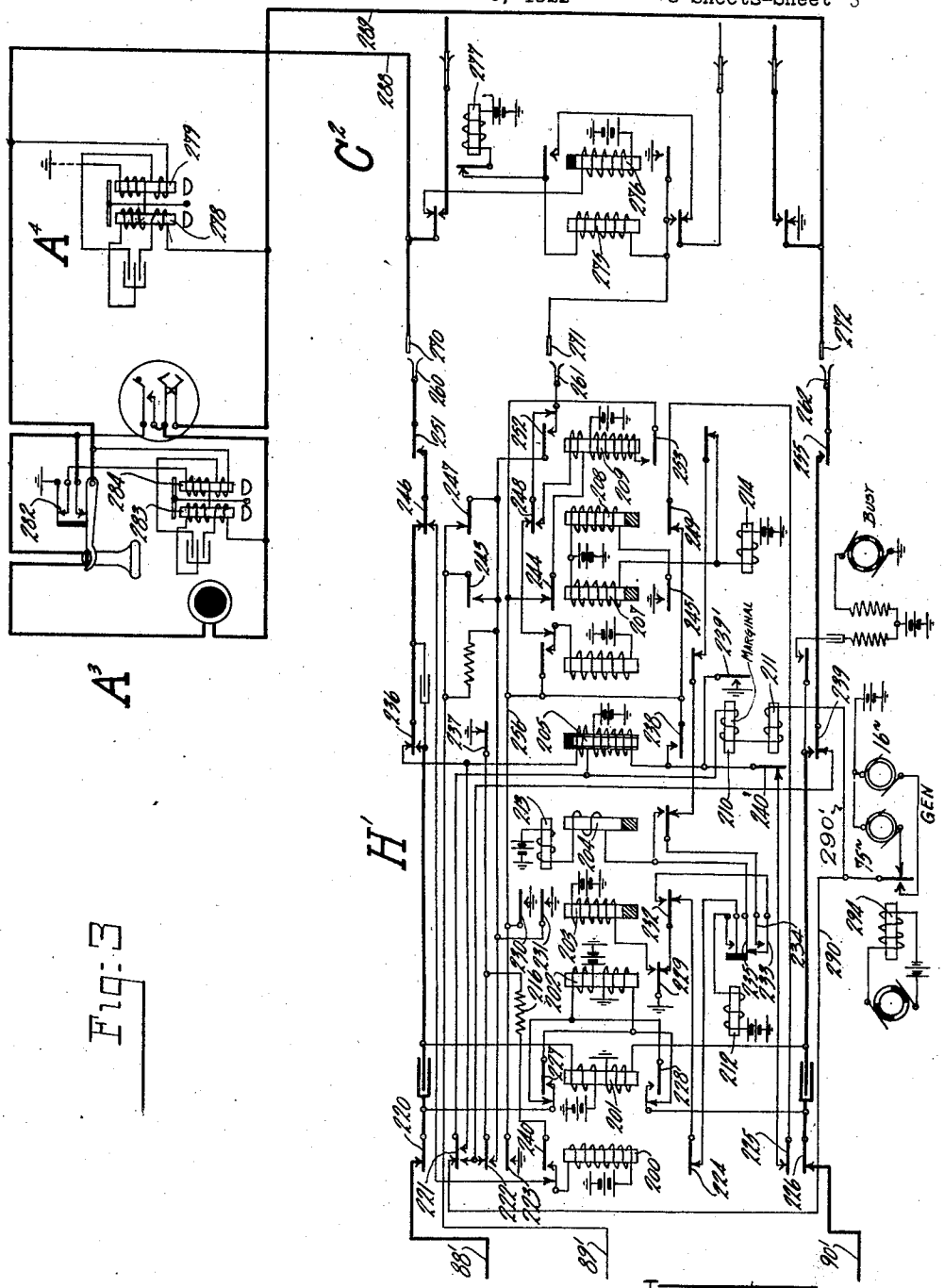


Fig. 3

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Patented Dec. 14, 1926. 1,610,438

UNITED STATES PATENT OFFICE.

JOHN E. GARDNER AND JOHN I. BELLAMY, OF CHICAGO, ILLINOIS, ASSIGNORS, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

AUTOMATIC TELEPHONE SYSTEM.

Application filed October 9, 1922. Serial No. 593,413.

The present invention relates in general to automatic telephone systems, but is more particularly concerned with systems of this character employing party lines; and the general object of the invention is to provide a novel and improved party line system in which revertive calls may be made, that is, calls from one subscriber on one line to another subscriber on the same line, in the same manner as ordinary calls by dialling the regular directory number of the desired party.

More particularly it is the object of the invention to provide automatic ringing on revertive calls. To explain more fully, a subscriber desiring to call another party on his own line dials the regular directory number of that party and the connection is established in the usual manner through the regular trunking system. Responsive to the establishment of the connection, automatic ringing equipment is placed in operation and the desired party is signalled in the same manner as if an ordinary call were in progress. When the called party responds the ringing current is disconnected and the talking circuits are established.

An additional object of the invention is to change the circuits of the connector switches, which are used to extend connections to party lines, so that on revertive calls the response of the wanted subscriber brings about the release of the connector switch and selector switches, talking battery being fed to both calling and called subscribers from the windings of the line relay of the first selector.

Another object of the invention is to give the calling subscriber when he makes a revertive call the regular ringing induction to inform him when the desired connection is established.

There are other objects of the invention, which have not been mentioned, but which, together with the foregoing, will be described hereinafter with reference to the accompanying drawings.

Referring now to the drawings comprising Figs. 1, 2, and 3, Figs. 1 and 2, when placed side by side with the corresponding lines at the ends thereof in alignment, show by means of the usual circuit diagrams a connection from the calling substation A on a party line to another substation A′ on another party line and also a connection from the substation A to the substation A^2 on the same line as the calling substation. Fig. 3 shows a modification of the invention, which is preferable where only two party line service is to be given.

Referring now more particularly to Fig. 1, in the upper left hand portion of the sheet in shown a four party line having the substation A thereon. The substation A is similar to the usual automatic type. However, its circuits have been modified so as to enable the same to be used with the present invention.

While only the circuits of one substation on the party line have been shown herein, it will be understood that the other three substations thereon, the ringers of which have been indicated, will be similar to the substation A. The party line terminates at the exchange in an individual line or trunk selecting switch C.

The line switch C is of the usual rotary type of mechanical construction whose wipers have no normal position, always standing, when idle, with its wipers in association with the bank contacts of the trunk line last used. The line switch C, in common with a plurality of other line switches, has access to trunk lines leading to first selector switches, one of these trunk lines being shown in the drawings extending to the selector E and terminating in the bank contacts 27–29, inclusive.

The selector E is of the usual Strowger vertical and rotary type and has access to trunk lines extending to second selector switches, such as the trunk line terminating in the bank contacts 73–75, inclusive, and extending to second selector E′.

While the second selector E′ has been indicated in the drawings by means of a rectangle, it will be understood that this second selector is similar to the first selector E. The selector E′ has access to trunk lines extending to connector switches, one of these trunk lines being the trunk line shown in the drawings extending to the connector H, Fig. 2.

The connector H is of the usual Strowger vertical and rotary type and has access to party lines, one of these being the one upon

which the substation A′ is located and another being the one with which the substation A is associated.

The substation A′ is similar to the substation A already described.

The party line with which the substation A′ is associated terminates at the exchange in the line switch C′ as well as in multiple bank contacts accessible to connector switches such as H.

Line switch C′ is the same as the line switch C before described.

In order to enable each of four parties on the same line to be selectively signalled, harmonic ringing is employed. Four groups of connectors have access to one party line and each group has a different frequency of ringing current associated with it. To signal the desired party on the party line it is only necessary to select a connector in the particular group. This is the scheme of harmonic ringing ordinarily used in automatic systems.

In Fig. 3 there is shown a modification of the connector H and also of the substation A which is adapted for two party line use. The connector H′ is similar to the connector H with the circuits of the same slightly modified.

The substation A^3 is similar to substation A with the circuits modified for two party line service.

In Fig. 3 harmonic ringing is employed and the same scheme of selecting frequency is applicable as described in connection with Figs. 1 and 2.

The apparatus illustrated in the drawings having been briefly described, the operation of the same will now be explained, first with reference to Figs. 1 and 2 and then to the modification shown in Fig. 3.

It will first be assumed that the subscriber at substation A desires to talk to the subscriber at the substation A^1. In order to do this the calling subscriber will remove his receiver and operate his calling device in according with the digits of the called subscriber's number.

When the receiver is removed at substation A, a circuit is completed extending from ground by way of switch-hook spring 5 and its working contact, armature 3 and its back contact, through the winding of slow-to-operate relay 1 in multiple with the non-inductive resistance 2, working contact of switchhook 6 and the said switchhook, line conductor 11, armature 18 and its back contact, and through the winding of the line relay 16, to battery. The line relay 16 and slow-to-operate relay 1 energize over this circuit. Relay 1, upon operating, at armature 3 opens the previous circuit for the line relay 16 and itself. However, the relay 1 and the line relay 16 are maintained energized over a circuit which includes the two line conductors 11 and 12 in series. Relay 16, upon energizing, at its armature 23 closes the circuit for the switching relay 15, in series with the motor magnet 17 and at its armature 22 connects the test wiper 25 to the above circuit at a point midway between the switching relay and the said motor magnet. The trunk selecting operation of the line switch C is now accomplished in the usual manner, the switching relay being short circuited and the motor magnet operating as a buzzer as long as bank contacts associated with busy trunk lines are in engagement with the switch wipers 24–26, inclusive. When an idle trunk is selected, which, it will be assumed, is the trunk line terminating in the bank contacts 27–29, inclusive, switching relay 15 is energized as there is no ground potential upon the test contact 28. Upon energizing, relay 15, at its armature 19 connects ground to the test contact 28 in order to busy the associated trunk line, at armatures 18 and 20 disconnects the line conductors 11 and 12 from the winding of the line relay 16 and from ground, respectively, and extends them by way of the front contacts of these armatures, wipers 24 and 26, bank contacts 27 and 29, to the upper and lower windings of the line relay 50 of the selector E.

The line relay 50 of the selector E is immediately energized over the calling line loop and operates at its armature 58 to close the circuit of the slow acting relay 51. The latter relay, upon operating, at armature 60 prepares the impulsing circuit of the selector E and at armature 59 places ground upon the release trunk conductor 78 thereby completing a holding circuit for the line switch C. This circuit may be traced from grounded release trunk conductor 78 by way of test contact 28, test wiper 25, armature 19 and its front contact, through the winding of the switching relay 15, and through the winding of the motor magnet 17 to battery. This holding circuit serves to maintain the switching relay 15 energized throughout the connection and it will be understood that it is completed before the slow acting line relay 16 has had time to deenergize. A branch of this circuit also extends by way of the private normal conductor 36 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 throughout the existence of the connection.

The calling subscriber may now operate his calling device in accordance with the first digit of the desired number, thereby producing a series of interruptions in the circuit of the line relay 50 of the first selector E, which deenergizes a plurality of times in response thereto. At each deenergization, an impulse of current is sent to the vertical magnet 55

in series with the slow acting relay 52. The vertical magnet 55 operates to raise the switch wipers 70—72, inclusive, step by step until these wipers are brought opposite the desired level of bank contacts. The slow acting relay 52 is energized in series with the vertical magnet, and being slow acting, retains its armature attracted throughout the vertical movement of the switch. Upon the first vertical step, the off normal springs are shifted and a circuit is completed, which extends from ground upon release trunk conductor 78 by way of armature 64 and its front contact, working contact of off normal spring 65 and the said spring, back contact and armature 64, and through the winding of the stepping relay 53 to battery. Relay 53 energizes over this circuit and operates at armature 62 to establish a locking circuit for itself, and at armature 63 to prepare the circuit of the rotary magnet 57. Shortly after the vertical movement, the slow acting relay 52 deenergizes and completes the circuit of rotary magnet 57. Magnet 57 advances the switch wipers into engagement with the first set of bank contacts on the level selected and at armature 64 opens the locking circuit of the relay 53, which deenergizes, opening the circuit of the rotary magnet, which deenergizes also. Assuming that the first trunk line is busy, ground will be connected to the test contact engaged by the test wiper 71 and the stepping relay 53 will again be energized. Relay 53 operates to establish a locking circuit for itself and to complete the rotary magnet circuit. Magnet 57 is again energized to open the locking circuit of the stepping relay and to advance the switch wipers into engagement with the bank contact set associated with the next trunk line. As the locking circuit of the stepping relay 53 is opened by the rotary magnet this relay deenergizes, opening the circuit of the rotary magnet, which also deenergizes. The alternate operation of the stepping relay 53 and the rotary magnet 57 continues until the switch wipers engage a bank contact set associated with an idle trunk line. Assuming that the trunk line terminating in the bank contacts 73—75, inclusive, is the first idle trunk line in the level, when the switch wipers are brought into engagement with this set of bank contacts, stepping relay 53 is not energized and the switching relay 54 energizes in series with the stepping relay 53. Due to the comparatively high resistance of the switching relay 54 the stepping relay 53 is not operatively energized over this circuit. Upon operating, relay 54 places ground upon the test contact 74 of the selected trunk line at armature 67, at armature 68 opens the circuit of the slow acting relay 51, at armatures 66 and 69 disconnects the line relay 50, and at the front contacts of these armatures extends the calling subscriber's line to the windings of the line relay of the second selector E′.

The line and release relays (not shown) in the selector E′ operate in the usual manner to prepare the switch circuits for operation and to establish a holding circuit for the selector E and line switch C.

In response to the next operation of the calling device, a series of interruptions is produced in the circuit of the line relay of the selector E′. The line relay operates to control the vertical magnet in raising the switch wipers 80—82, inclusive, step by step until the said wipers are raised opposite the level of bank contacts corresponding to the number of interruptions in the digit dialled. At the termination of the vertical movement of the switch, its trunk hunting movement is initiated and continues until the wipers of the switch are brought into engagement with a set of bank contacts associated with an idle trunk line. It will be assumed that the trunk line comprising conductors 88—90, inclusive, and terminating in the bank contacts 83—85, inclusive, is the one selected. When this selection takes place, the switching relay of the selector E′ energizes, and among other results extends the calling subscriber's line to the line relay 102 of the connector H.

The line relay 102 of the connector H energizes and operates its armature 129 to establish a circuit for the slow acting relay 103. Upon operating, the latter relay at armature 132 prepares the impulsing circuits of the connector H and at armature 131 places ground upon the release trunk conductor 89 over a circuit which includes armature 149 and its back contact on the slow acting relay 108. The grounding of release trunk conductor 89 completes a holding circuit for the switches E′, E and C.

When the calling device at the calling substation is operated in accordance with the next digit of the desired number, the line circuit of the line relay 102 is opened a plurality of times. Responsive to the openings in its circuit the line relay 102 deenergizes a corresponding number of times, each time sending an impulse of current to the vertical magnet 111. The circuit over which the first of these impulses is sent may be traced from ground by way of armature 129 and its back contact, armature 132 and its front contact, off normal springs 133 and 135 through the winding of the slow acting relay 104 and through the winding of the vertical magnet 111 to battery. 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 different circuit, which is similar to the one above traced, except that it includes the off normal springs 133 and 134 and armature 137 and its front contact on the slow acting relay 104, which

relay is energized in series with the vertical magnet over the previously traced circuit. Vertical magnet 111 operates to step the switch wipers 165–167, inclusive, opposite the proper level of bank contacts in accordance with the number of interruptions produced in the circuit of the line relay 102. The slow acting relay 104 maintains its armature attracted throughout the vertical movement of the switch and operates in the manner before described to preserve the continuity of the vertical magnet circuit. At the termination of the vertical movement of the switch, relay 104 deenergizes and prepares the circuit of the rotary magnet 113.

The calling subscriber at substation A may now operate his calling device in accordance with the next and final digit in the desired number, whereupon a series of interruptions is produced in the circuit of the line relay 102. In responding to these interruptions, the line relay 102 at each deenergization sends an impulse of current to the rotary magnet 113 over the following circuit: ground by way of armature 129 and its back contact, armature 132 and its front contact, off normal springs 133 and 134, armature 137 and its back contact, back contact and armature 144, armature 154 and its back contact, and through the winding of the rotary magnet 113 to battery. The magnet 113 operates to rotate the switch wipers 165–167, inclusive, into engagement with the set of bank contacts with which the line of the substation A′ is associated, this being the one desired by the calling subscriber. As shown in the drawings, this bank contact set comprises contacts 171–173, inclusive. The slow acting relay 107 is energized in multiple with the rotary magnet 113 and operates, at its armature 146 to short circuit the armature 149 and its back contact on the relay 108, at armature 156 to open a point in the circuit of the upper winding of switching relay 109, and at armature 147 to close a circuit for the slow acting relay 108. The latter relay, upon operating, prepares a point in the circuit of the upper winding of relay 109 at armature 150, opens the springs comprising armature 149 and its back contact, to remove one ground connection from the release trunk conductor 89. However, this last operation is ineffective at the present time as the springs comprising armature 146 and its front contact are now closed as the relay 107 is energized. Another result of the energization of relay 108 is that at armature 148 a testing circuit, including the winding of relay 100, is prepared. At the termination of the rotary movement of the switch, the wipers 165 and 167, inclusive, will be in engagement with the bank contacts 171–173, inclusive, and the slow acting relay 107 will deenergize. As a result of the deenergization of relay 107, the circuit of the slow acting relay 108 is opened at armature 147, a testing circuit is completed, which includes the upper winding of switching relay 109, at armature 156, and at armature 146 direct ground is removed from the release trunk conductor 89 for a short interval until the relay 108 deenergizes. The switches E′, E and C are not released at this time as their holding circuit is still maintained closed by ground through the resistance 114. However, the ground potential upon the private normal conductor 36 is reduced so that if the wipers of the connector H were in engagement with the bank contacts associated with the calling line the connector could make connection with that line. These provisions are made in order that revertive calls may be extended as will appear later.

Assuming that the desired line is idle at the present time there will be no ground potential upon the test contact 172, and the switching relay 109 will be energized over a circuit which extends from ground upon conductor 157 by way of back contact and armature 156, through the upper winding of switching relay 109, front contact and armature 150, normally closed springs controlled by armature 152, test wiper 166, test contact 172, through the winding of switching relay 175 in the line switch C′, and through the winding of the motor magnet 176 to battery. Both relays 109 and 175 are energized over this circuit. However, the switching relay 175 only attracts its armatures enough to disconnect the line of the substation A′ from its normal battery and ground connections in the line switch C′, on account of a mechanical interlocking device controlled by the armature of the line relay 177 which is now normal.

In the connector H, switching relay 109, upon energizing, establishes a locking circuit for itself at armature 153, opens the rotary magnet circuit at armature 154, at armature 152 connects direct ground to the test wiper 166 and at armatures 151 and 155 prepares the signalling circuit. Shortly after the energization of relay 109 the slow acting relay 108 deenergizes and again connects direct ground to the release trunk conductor 89 at armature 149 and at armature 148 opens a point in the testing circuit including the winding of relay 100 and at the back contact of this armature completes the signalling circuit. Ringing current from the generator Gen. is now intermittently projected out on the call line in order to operate the signalling device at substation A′. As the proper frequency of ringing current has been selected by the operation of selector E′ only the bell at substation A′ will be rung.

When the subscriber at substation A′ responds by removing his receiver the ring cut

off relay 105 is energized over a circuit which extends from ground at substation A′ by way of spring 182 and its working contact, armature 183 and its back contact, through the winding of the slow to operate relay 180 in multiple with the non-inductive resistance 181, by way of working contact of switch-hook spring 185 and said spring, line conductor 186, bank contact 171, wiper 165, armature 151 and its front contact armature 148 and its back contact, armature 138 and its back contact, and through the upper winding of the ring cut off relay 105 to battery or to the ungrounded pole of the generator. The ring cut off relay 105 is energized over this circuit. Relay 105, upon operating, closes a locking circuit for itself at armature 140, at armature 141 connects the balancing impedance 112 to the lower talking conductor, at armatures 138 and 142 disconnects the ringing current, and at the front contacts of these armatures completes the talking circuit. The slow to operate relay 180 in the substation A′ energizes and at armature 183 disconnects the ground connection from the line conductor 186 and at armature 184 prepares another circuit which will be described later. The back bridge relay 101 is energized over the call line loop and operates at armatures 127 and 128 to reverse the connections of the line relay 102 with regard to the trunk conductors 88 and 90 thereby reversing the current flow in the calling line. Talking battery is supplied to the calling line from the windings of the line relay 102 and to the called line from the windings of the back bridge relay 101. The balancing impedance 112 is connected to the lower talking conductor in order to balance the line, which, it will be noticed, has all the bell coils with the exception of those of the called station A′ connected from the upper heavy talking conductor to ground. Without this balancing impedance the talking circuit would have a tendency to be slightly noisy.

When the conversation is terminated the release of the connection takes place upon the calling subscriber replacing his receiver. When the receiver is replaced at substation A, ground is momentarily connected to the line conductor 11 over a circuit extending from ground by way of switch hook spring 5 and its resting contact, armature 4 and its front contact to line conductor 11. When the slow acting relay deenergizes this ground is disconnected and the line relay 102 in the connector H deenergizes thereby opening the circuit of the slow acting relay 103. Upon the deenergization of relay 103, the release magnet 136 of the connector H is energized and ground is removed from the release trunk conductor 89 whereby the holding circuit of the switches E′, E and C is opened. The release magnet 136 of the connector H restores this switch to normal in the usual manner, its own circuit being opened at the off normal springs when the switch shaft reaches its normal position.

The selectors E′ and E are released by their respective release magnets in the usual manner. The disconnection of ground from the release trunk conductor 89 also causes the switching relay 15 in the line switch C to deenergize. In the above manner the connection is released.

It will now be assumed that when the wipers of the connector H are brought into engagement with the bank contacts 171–173, inclusive, of the called station, this line is busy. Under these conditions, there will be a ground potential upon the test contact 172, and the switching relay 109 will not be energized. Then, upon the deenergization of the slow acting relay 108, a circuit is completed for the busy relay 106. Upon operating, relay 106, closes a locking circuit for itself at armature 143, opens the circuit of the rotary magnet at armature 144, and at armature 145 connects a lead from the busy signalling machine to the lower heavy talking conductor. Responsive to the latter operation the calling subscriber receives an audible signal, which informs him that the desired line is inaccessible for the present. Responsive to the replacement of the receiver at the calling substation, the release of the connection occurs in the same manner as before.

The ordinary operation of the system when one subscriber calls another on a different line from his own having been described, its operation when a subscriber desires to call a party on his own line will now be explained. In order to describe this, it will be assumed that the subscriber at substation A desires to call the party at substation A^2 on his own line only the ringer of this substation being shown in the drawings. To call this subscriber the party at substation A will dial the regular directory number of the subscriber at substation A^2. Responsive to these operations the connection is extended in the same manner as described before through switches such as C, E, E′, and H. However, the connector H functions in a slightly different manner when connection is made with the terminals 168–170, inclusive, of the called line. In this case as the called line is also the calling line, the operation of the relays 107 and 108 cause a reduction in the ground potential upon the test contact 169 just as the wipers 165–167, inclusive, are testing this line. The ground potential is reduced sufficiently to allow the switching relay 109 to energize from battery through the windings of the switching relays 15 and 54 in the line switch C, and selector E, respectively, and the switching relay of the selector E′ all

in multiple. Relay 109 operates in the same manner as before to open the rotary magnet circuit, to establish a locking circuit for itself, to place direct ground upon the test contact 169, and to prepare the signalling circuit. As the wipers of the connector H are now connected to the calling line and the receiver is removed at substation A a circuit is completed which extends from ground by way of back contact and armature 139, armature 121 and its back contact, back contact and armature 142, front contact and armature 155, wiper 167, bank contact 170, normal conductor 37, line conductor 12, calling device springs at substation A, transmitter, receiver, relay 1, working contact of switchhook 6 and said switchhook, line conductor 11, normal conductor 35, bank contact 168, wiper 165, armature 151 and its front contact, armature 148 and its front contact, normally closed springs controlled by armature 123, and through the winding of relay 100 to battery. Relay 100 is energized over this circuit and operates at armature 123 to establish a rocking circuit for itself in series with the resistance 115, at armature 122 places an additional ground upon conductor 157, at armature 121 disconnects the ground connection from wiper 167 and connects an additional ground potential to the release trunk conductor 89, and at armature 124 opens a point in the release circuit. Further results of the energization of relay 100 are that the line relay 102 is disconnected from the line of the substation A. Relay 102 immediately deenergizes opening the circuit of the slow acting relay 103. After a short interval relay 103 deenergizes. However, as the relay 100 is now operated the deenergization of the relay 103 has no results at the present time. Upon the deenergization of the slow acting relay 108 ringing current from the generator Gen. is projected out on the conductor 35 and over line conductor 11 to the ringers on the party line on which the substation A^2 is located. The proper frequency of ringing current having been selected by the selector E′ in its vertical operation, the ringer at substation A^2 is the only one operated. Due to the fact that there is no direct ground connection upon the conductor 37 or 12 the calling subscriber at substation A who has his telephone set bridged across the line conductors does not receive a disagreeable noise in this receiver. In the connector H there is a ground connection to the conductor 37 and thence to the line conductor 12 through the high resistance 158. This serves to allow a small amount of ringing current to pass through the receiver at substation A thus giving the subscriber thereat the usual ringing induction, and serves also to form a high resistance return circuit for the battery current on which the ringing current is superimposed, thus maintaining relay 1 at the substation A energized, but not operating ring cut-off relay 105 because of the high resistance of 158.

When the subscriber at substation A^2 responds ground is momentarily connected to the line condutcor 11 in the same manner as has been described in connection with the substations A and A′. This ground impulse causes the energization of the ring cut off relay 105 in the connector H. Upon operating, relay 105 at armature 140 establishes a locking circuit for itself, at armatures 138 and 142 disconnects the ringing current, and at armature 139 disconnects ground from the release trunk conductor 89 and also from the winding of the relay 100. Relay 100 deenergizes to open the locking circuit of relay 109 and also to complete the circuit of the release magnet 136. Magnet 136 operates to restore the connector H to normal. The disconnection of ground from the release trunk conductor 89 brings about the release of the selectors E′ and E, and the switching relay in the line switch C. As the receivers are removed at substations A and A^2 on the party line, the line relay 16 of the line switch C immediately energizes and this line switch seizes the selector E or another selector in the usual manner. Talking battery is now supplied to both subscribers on the party line from the windings of the line relay of the seized selector. The seized selector and line switch C are released upon both subscribers replacing their receivers.

The above is the operation of the system when a revertive call is made and the called subscriber answers. Under certain conditions, however, the subscriber called may not answer and in this case it becomes desirable to release the connection upon the calling subscriber replacing the receiver. In order to describe the operation in this case we will assume that the subscriber at substation A^2 does not answer and that the subscriber at substation A replaces his receiver. In response to the latter operation a momentary ground impulse is sent over the line conductor 11 and the normal conductor 35 to energize the ring cut off relay 105. The ring cut off relay operates in the same manner as before to bring about the release of the connector H and also of the switches E′, E and C. Due to the fact that the receiver is replaced at the substation A there is no circuit for the line relay 16 of the line switch C and this line switch does not again operate to seize a selector. In this manner the connection is released responsive to the replacement of the receiver at the calling substation A.

The operation of the invention shown in Figs. 1 and 2, having been described, the op-

eration of the modification, which is adapted for two party line use, will now be described with reference to Fig. 3. To describe the operations of the system when the connector H′ is used it will be assumed that a subscriber desires to call the subscriber at substation A^3. To accomplish this result the subscriber at the calling substation will remove his receiver and operate his calling device for the digits of the directory number of the subscriber at substation A^3. When the receiver is removed at the calling substation the line relay of the line switch associated with the line of the substation calling is energized and initiates the operation of this switch in the usual manner. The operations of the calling line switch and the first and second selectors are similar to those described before in the preceding connection. It will be assumed that the line switch, on the calling line, and selectors similar to the selectors E and E′ are operated to extend the connection to the connector H′, Fig. 3 over the trunk line comprising conductors 88′–90′, inclusive. The line relay 202 of this switch operates in a similar manner to the line relay of the connector H to close the circuit of the slow acting release relay 203. Upon operating, relay 203 prepares the operating circuits of the connector H′ at armature 232 and at armature 231 places ground upon the release trunk conductor 89′ to establish the usual holding circuit for the previously operated switches.

In response to the first operation of the calling device at the calling substation the vertical magnet 213 is operated under control of the line relay 202 to raise the switch wipers 260–262, inclusive, step by step, until the wipers are placed opposite the proper level of bank contacts. Slow acting relay 204 is energized in series with the vertical magnet and operates to maintain its armature attracted throughout the vertical movement of the switch, thereby maintaining the vertical magnet closed when the off normal springs are shifted, which operation occurs upon the first vertical step of the switch. Upon deenergizing at the end of the vertical movement, the slow acting relay 204 transfers the impulsing circuit to the rotary magnet 214.

When the calling device at the calling substation is operated in accordance with the next and final digit in the desired number the rotary magnet 214 is operated under control of the line relay 202 and operates to advance the switch wipers into engagement with the bank contact set comprising contacts 270–272, inclusive, associated with the line of the substation A^3. The relays 207 and 208 are energized and function in a manner similar to that described in connection with the connector H.

Assuming that the desired line is idle at this time, the switching relay 209 is energized in series with the switching relay 275. Relay 275 of the line switch C^2 operates to disconnect the line of the called substation from its normal battery and ground connection in the line switch. Relay 209, upon operating, establishes a locking circuit for itself at armature 253 and at armatures 251 and 255 prepares the signalling circuit. Upon the deenergization of relay 208 the signalling circuit is closed. This circuit extends from the generator lead 290 by way of back contact and armature 221, through the upper winding of the ring cut off relay 205, back contact and armature 236, back contact and armature 246, front contact and armature 251, wiper 260, bank contact 270, over the line conductor 288, lower right hand winding of the ringer, condenser, lower left hand winding of the ringer, springs of the calling device, line conductor 289, bank contact 272, wiper 262, armature 255 and its front contact, armature 239 and its back contact, back contact and armature 222, armature 237 and its back contact, to ground. The ringing current flowing through the lower windings of the ringer at substation A^3 causes the bells to be actuated in the ordinary manner. This ringing current also flows through the ringer at substation A^4. However, as a particular frequency of ringing current has been selected by the operation of the selector E′ to pick out a particular group of connectors, only the bell of the substation A^3 responds. When the receiver is removed ring cut off relay 205 is energized over the called line loop and operates, to establish a locking circuit for itself at armature 238, and to disconnect the ringing current and to complete the talking circuit at armatures 236 and 239. The back bridge relay 201 is energized over the called line and operates to reverse the connections of the line relay 202 with regard to the incoming trunk conductors for supervisory or metering purposes in the usual manner.

When the conversation is terminated the release of the connection takes place in the usual manner.

If the line of the substation A^3 is busy when the wipers of the connector H′ are brought into engagement with the bank contact 270–272, inclusive, the busy signal is given to the calling subscriber in a manner similar to that already described in the operation of the connector H.

It will now be assumed that the subscriber at substation A^4 desires to call the other party at substation A^3 on his own line. In this case the operation is substantially the same as before described. That is, the line switch C^2, and selectors similar to the selectors E, and E′ are operated to seize a connector such as the connector H′. This switch is in turn operated in the same man-

ner as before, the only difference being that when its wipers are brought into engagement with the bank contacts 270–272, inclusive, the relays 207 and 208 operate conjointly to bring about a reduction of the ground potential on the test contact 271 in order to energize the switching relay 209 in the same manner as before described in connection with the connector switch H, Fig. 2. Upon operating, relay 209 establishes a locking circuit for itself and prepares points in the signalling circuit. As the receiver is removed at substation A^4, relay 200 is energized over the calling line loop and operates to establish a locking circuit for itself at armature 240. Other results of this energization are that at armature 221 relay 200 prepares certain points in the signalling circuit, at armature 222 disconnects ground from the wiper 262 and connects it to conductor 89′, at armature 223 places ground upon the conductor 256, at armature 224 opens a point in the release magnet circuit, and at armatures 220 and 226 disconnects the line relay 202 from the calling line. Relays 202 and 203 deenergize. However, their operation is of no particular function at the present time. Still another result of the energization of relay 200 is that a circuit is prepared for the lower winding of the ring cut off relay 205. Upon the deenergization of relay 208, the ringing circuit is completed and also the circuit of the lower winding of relay 205 at armatures 246 and 249, respectively.

The ringing circuit may be traced from the generator lead 290′ through the alternating current relays 211 and 210 in series, armature 221 and its front contacts, to wipers 260 and 262, thence over the line conductors of the substantion A^4, through the ringer of the substation A^3 to ground. The circuit may be traced over the line conductors 288 and 289 in parallel through the lower windings of the bell coils 283 and 284, through the condenser, and through the upper windings of the bell coils to ground by way of switchhook springs 282. Thus the ringer at substation A^3 is actuated over a simplex circuit which includes the two line conductors in parallel. As this circuit is opened at substation A^4 by the receiver being off the switchhook the signalling device at substation A^4 is not actuated. It will be remembered that when the ringing circuit is completed a circuit is also closed for the lower winding of the ring cut off relay 205. However, the ring cut off relay does not energize at this time due to the fact that it is slow to operate and that this circuit is immediately opened at armature 240′, by the energization of alternating current relay 211. The alternating current relay 210 in series with relay 211 is marginal and is not operated in series with the ringer at substation A^3. All the time the interrupter relay 294 is in operated position ringing current from the 16 cycle generator is supplied to the line of the called substation in order to actuate the ringer thereat. During the silent period when the relay 294 is deenergized the 75 cycle generator is connected over the ringing circuit. The ringers at the substations A^4 and A^3 are adapted not to respond to this frequency and are therefore not actuated. However, the alternating current relay 211 is maintained energized. When the subscriber at substation A^3 responds by removing his receiver the previously traced simplex circuit is opened by the operation of the switchhook and the alternating current relay 211 deenergizes and completes the circuit of the ring cut off relay 205. Upon operating, relay 205, establishes a locking circuit for itself at armature 238, opens the ringing circuit at armatures 236 and 239 and at armature 237 removes ground from the release trunk conductor 289′ and also opens the locking circuit of the raly 200. The disconnection of ground from the release trunk conductor 89′ and the denergization of the relay 200 bring about the release of the connection in the same manner as has been before described. As the receivers at the substations A^4 and A^3 on the calling line are now removed the line switch C^2 will operate to seize the selector used in the preceding connection or another selector. Talking battery is now supplied to the subscribers from the line relay of the seized selector. The connection comprising the switches C^2 and the seized selector is released when both receivers are replaced on the party line.

In the previous connection it will now be assumed that the subscriber at substation A^3 did not respond and that the subscriber at substation A^4 replaces his receiver. Responsive to the latter operation the ringer at substation A^4 is included in the simplex ringing circuit and the impedance of the circuit is accordingly decreased thus allowing a greater amount of current to flow through the marginal alternating current relay 210, which immediately energizes and closes the circuit of the ring cut off relay 205. The energization of the ring cut off relay 205 brings about the release of the connection in the same manner as has been before described.

It will be noted that the modification shown in Fig. 3 is particularly adapted for two party line use inasmuch as the talking circuit is perfectly balanced and it is unnecessary to make special provision at the substations on the party line for giving a momentary ground impulse over one conductor of the line.

It will be seen that by the use of the system shown in Figs. 1 and 2, or 3, it is pos-

sible to make a revertive call back to a desired subscriber on the same line as the calling one in the same manner as if an ordinary call were being made to another subscriber and in the case of this revertive call all the switches are released when an answer is obtained with the exception of the line switch and the first selector, thereby materially reducing the number of switches necessary in the connection.

The features of the invention having been described what is considered to be new and desired to have protected by Letters Patent will be pointed out in the appended claims.

What we claim is:

1. In a telephone system, a telephone line having a plurality of stations thereon, a selector switch and a connector switch whereby a calling subscriber at one of said stations may extend a connection to said line, a source of ringing current, and means in said connector automatically responsive to the establishment of said connection for intermittently applying said source to one side only of said line to signal a station thereon.

2. In a telephone system, a telephone line having a plurality of stations thereon, a connector switch under control of a calling subscriber at one of said stations for extending a connection to said line, automatic ringing equipment in said connector, means operative responsive to the establishment of said connection for initiating the operation of said ringing equipment to apply ringing current to one side only of said line at predetermined intervals to signal station thereon, and means for opening the other side of said line to substantially prevent the ringing current from returning thereover.

3. In a telephone system, a telephone line having a plurality of stations thereon, an automatic switch, means controlled from one of said stations for operating said switch to extend a connection to said line, automatic ringing equipment in said switch, means operative responsive to the establishment of said connection for operating said ringing equipment to intermittently apply ringing current to one conductor of said line while the receiver is removed at the calling substation thereon, a return path for the ringing current independent of said line and means for preventing a part of said ringing current from returning over the other conductor of said line.

4. In a telephone system, a telephone line having a plurality of stations thereon, an automatic switch, means controlled from one of said stations for operating said switch to extend a connection to said line, automatic ringing equipment in said switch, means operative responsive to the establishment of said connection for operating said ringing equipment to apply ringing current to said line, and means for disconnecting said ringing current responsive to the removal of the receiver at the called station on said line whenever such removal takes place.

5. In a telephone system, a telephone line having a plurality of stations thereon, an automatic switch, means controlled from one of said stations for operating said switch to extend a connection to said line, automatic ringing equipment in said switch, means operative responsive to the establishment of said connection for operating said ringing equipment to apply ringing current to said line, and means for preventing a part of said current from traversing the receiver at the calling substation on said line.

6. In a telephone system, a telephone line having a plurality of stations thereon, an automatic switch, means controlled from one of said stations for operating said switch to extend a connection to said line, automatic ringing equipment in said switch, means operative responsive to the establishment of said connection for operating said ringing equipment to intermittently apply ringing current to said line, and a leakage path for said current whereby a portion of said current is shunted through the receiver at the calling substation on said line.

7. In a telephone system, a telephone line having a plurality of stations thereon, an automatic switch, means controlled from one of said stations for operating said switch to extend a connection to said line, automatic ringing equipment in said switch, means operative responsive to the establishment of said connection for operating said ringing equipment to apply ringing current to said line, and means always immediately responsive to the removal of the receiver at the called substation for releasing said switch.

8. In a telephone system, a telephone line having a plurality of stations thereon, a selector switch and a connector switch whereby a calling subscriber at one of said stations may extend a connection to said line, a source of ringing current, means in said connector automatically responsive to the establishment of said connection for applying said source to said line to signal a station thereon, and means responsive to the removal of the receiver at the called substation on said line for releasing said switches.

9. In a telephone system, telephone lines, a plurality of stations on each of said lines, a connector switch under the control of a subscriber at one of the stations on one of said lines for extending a connection to another station on the same line or to a station on another line, means in said connector switch responsive in one case to the

establishment of the connection to periodically apply ringing current to the called line over the two sides of the called line in series, and means in said connector switch responsive in the other case to the establishment of the connection to periodically apply ringing current to the called line over one side of the line and ground.

10. In a telephone system, a party line, means including an automatic switch under the control of a calling station on said party line for extending the connection from said party line and back to said party line, means for signalling a called station on said line responsive to the establishment of said connection, and means also responsive to the establishment of said connection for altering the connection of the said line with said switch to substantially prevent the actuation of the calling subscriber's receiver.

11. In a telephone system, a subscriber's line, a telephone receiver, a bridge across said line including said receiver, a ringer connected to said line, means for extending a connection to said line, a source of signalling current, means for connecting said source to said ringer over said connection and over said line, and means effective responsive to the establishment of said connection for substantially preventing the actuation of said receiver by current from said source.

12. In a telephone system, a connector switch, a calling line, other lines, means for operating said connector switch under the control of said calling line to extend a connection to said calling line or to one of said other lines, a discriminating relay in said connector switch, means responsive to the establishment of any connection for connecting said discriminating relay to a talking conductor of the called line, and means for operating said discriminating relay over the called line only in case such line is also the calling line.

13. In a telephone system, a calling line, other lines, a connector switch, discriminating means in said connector switch, means under the control of said calling line for operating said connector switch to connect with the same or with one of said other lines, and means for operating said discriminating means over the two sides of the called line in series in one case and not in the other case.

14. In a telephone system, a calling line, a connector switch, a line relay for said connector switch, means associated with said line to operate said line relay to control the selecting movement of said connector switch to extend a connection to the calling line, and means in said connector switch for disconnecting said line relay responsive to said connection being established.

15. In a telephone system, a subscriber's line, a plurality of ringers connected to one side of said line, a connector switch, means for operating said switch to connect with said line, an impedance coil in said switch, and means for connecting said coil to the other side of said line to balance the effect of said ringers.

16. In a telephone system, a party line, a plurality of substations on said line, a connector switch under control of a calling subscriber at one of said stations for extending a connection to said line, automatic ringing equipment in said connector, means operative responsive to the establishment of said connection for initiating the operation of said ringing equipment to apply ringing current to said line to signal a station thereon, a relay at the calling substation, means controlled jointly by said relay and the associated switchhook for grounding said line momentarily when the receiver is replaced, and means responsive to said momentary grounding of said line for disconnecting said ringing current.

17. In a telephone system, a calling line, other lines, a connector switch, means under the control of said calling line for operating said switch to connect with said calling line or with one of said other lines, testing means in said switch, discriminating means in said switch for determining whether the line connected with is said calling line or one of said other lines, and means for connecting said discriminating means to the line connected with, said last means being ineffective in case the line connected with is a busy other line.

18. In a telephone system, a calling line, other lines, a connector switch, means under the control of said calling line for operating said switch to connect with said calling line or with one of said other lines, testing means in said switch, discriminating means in said switch for determining whether the line connected with is said calling line or one of said other lines, means for connecting said discriminating means to the line connected with during the time of testing, and means for maintaining said discriminating means operated independent of said connecting means.

19. In a telephone system, a telephone line having a plurality of stations thereon, a second telephone line, an automatic switch, means controlled from one of said stations for operating said switch to extend a connection to said first or said second line, automatic ringing equipment in said switch, means operative responsive to the establishment of a connection to either line for operating said ringing equipment to apply ringing current to one side of the connected line, a return path for ringing current from the other side of the connected line to said ring-

ing equipment, and means for opening said return path in case the connected line is said first line.

20. In a telephone system, a party line, a calling and a called station on said line, an automatic switch, means controlled from said calling station for operating said switch to connect with said line, means in said switch for automatically and intermittently signalling the called station, a ring cut-off relay in said switch for controlling said signalling means, and means responsive either to the replacement of the receiver at said calling station or to the removal of the receiver at said called station for operating said relay to interrupt the signalling of the called station.

21. In a telephone system, a party line, a calling and a called station on said line, an automatic switch, means controlled from said calling station for operating said switch to connect with said line, means in said switch for automatically and intermittently signalling the called station, a ring cut-off relay in said switch, means controlled by said relay for releasing said switch, and means responsive to either the replacement of the receiver at the calling station or to the removal of the receiver at the called station for operating said relay to disable said signaling means and to effect the release of said switch.

In witness whereof, I hereunto subscribe my name this 5th day of October, A. D., 1922.

JOHN E. GARDNER.

In witness whereof, I hereunto subscribe my name this 5th day of October, A. D., 1922.

JOHN I. BELLAMY.