July 31, 1923. 1,463,271

T. G. MARTIN

PARTY LINE TELEPHONE SYSTEM

Original Filed March 1, 1910 2 Sheets-Sheet 1

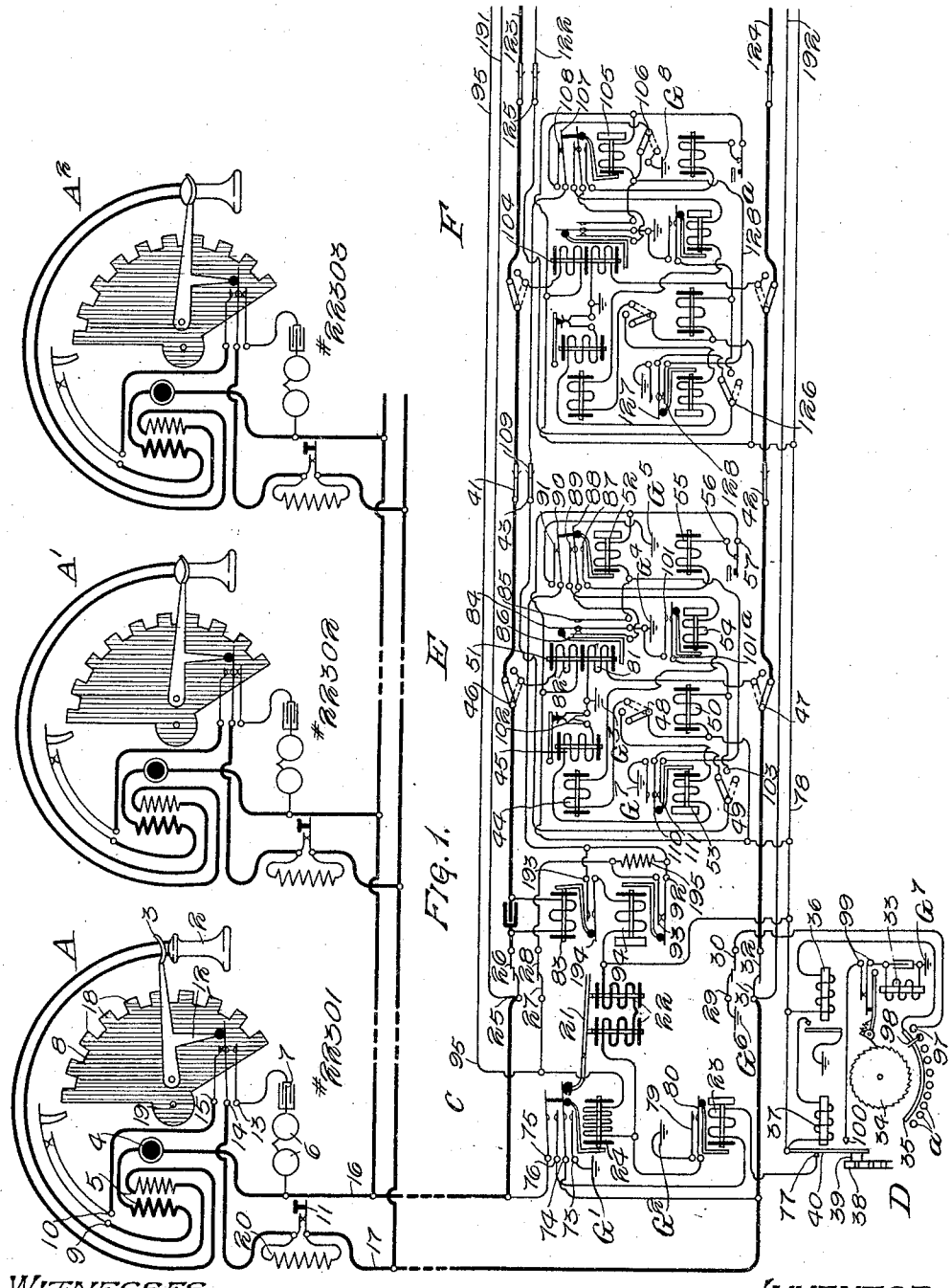

Fig. 1.

WITNESSES
A. J. Ray.
A. Andusen.

INVENTOR:
Talbot G. Martin
By Buckley Durand & Dorsey
ATTORNEYS.

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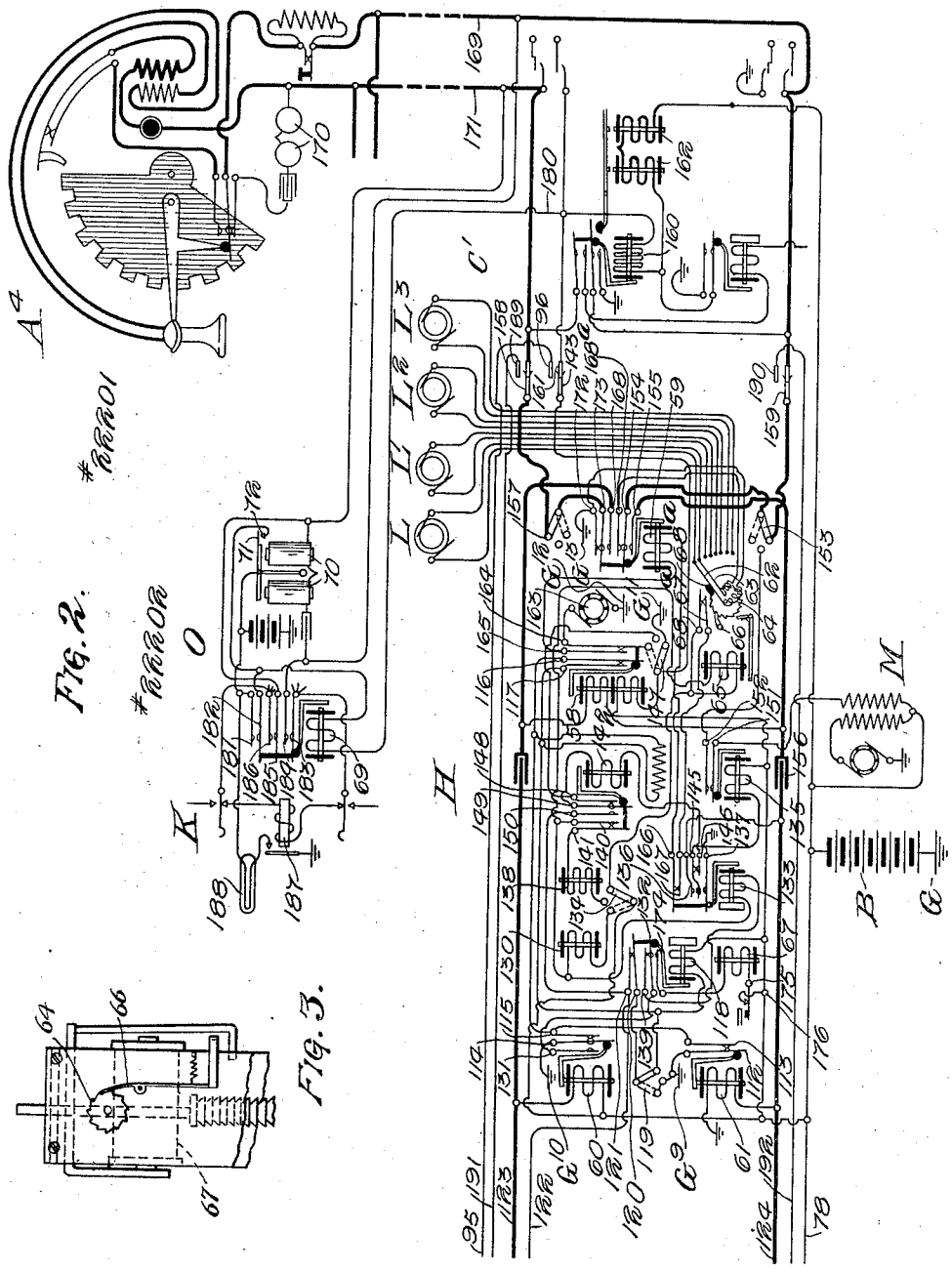

FIG. 2.



FIG. 3.

WITNESSES
A. J. Ray
A. Andersen.

INVENTOR:
Talbot G. Martin
By Bulkley Durand & Dung
ATTORNEYS,

Patented July 31, 1923. 1,463,271

# UNITED STATES PATENT OFFICE.

TALBOT G. MARTIN, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

## PARTY-LINE TELEPHONE SYSTEM.

Application filed March 1, 1910, Serial No. 546,582. Renewed September 20, 1916. Serial No. 121,313.

*To all whom it may concern:*

Be it known that I, TALBOT G. MARTIN, a citizen of the United States of America, and resident of Chicago, Cook County, Illinois, have invented a certain new and useful Improvement in Party-Line Telephone Systems, of which the following is a specification.

My invention relates to telephone exchange systems in general, but more particularly to party-line telephone systems, and especially to systems in which automatic switches are employed and controlled over the two sides of the telephone line in series, there being no operating grounds at the substations thereof.

An object of my invention is to provide means for selectively signaling the subscribers on a party-line in an automatic or semi-automatic telephone exchange system of that kind in which the automatic switches are controlled over the two sides of the calling line in series, systems of this kind being ordinarily known as two-wire systems, as distinguished from systems in which operating grounds are employed at the substations, which latter are commonly known as three-wire systems.

Another object is to provide a two-wire system having one or more connectors for seizing the called lines in accordance with the last digit of any called number, which are capable of doing this in any case, notwithstanding that the called line is also the calling line, which is, of course, the case when one party-line subscriber calls another on the same line, and which are provided with means for selectively signaling the called party-line subscriber.

Another object is to provide an arrangement whereby when a party-line subscriber is called whose telephone has been taken out or discontinued, the call will be received by a manual switchboard operator, and whereby other subscribers on the said line may be called in the regular way without having the call received by the said operator, thus making it possible to direct all calls for subscribers whose telephones have been taken out to a manual switchboard, even though one or more of the telephones thus taken out or discontinued were on party-lines, the arrangement being such that the operator is never called except when the call is for a subscriber whose telephone has been taken out or discontinued.

It is also an object to provide certain details and features of improvement tending to increase the general efficiency and serviceability of a telephone exchange system of this particular character.

To the foregoing and other useful ends my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings Figures 1 and 2 represent diagrammatically a complete circuit connection between a calling substation A (Fig. 1) and a called substation $A^4$ (Fig. 2), in a system embodying the principles of my invention.

Fig. 1 represents diagrammatically a party-line equipped with a number of telephones A, A′ and $A^2$. The party-line is connected to an individual or line switch C at the central office. A group of line switches C is controlled by a common mechanism D which is usually called a master switch. At E is shown a first selector switch and at F a so-called second selector is represented.

In Fig. 2 there is represented a second party-line, only one of the substations ($A^4$) of which is shown. At O is shown a device which may be connected to a party-line to signal an operator or exchange attendant when the number of a telephone that has been disconnected from the line is called. At C′ is shown a line switch similar to the switch C (Fig. 1). At H is shown my improved connector for completing connection with party-lines. At L, L′, $L^2$ and $L^3$ are shown a number of ringer generators and at M a busy signaling machine is represented. A battery B having one terminal grounded is provided for the purpose of supplying current for operating the central office switches and for talking purposes.

Fig. 3 is a detail view of a portion of the connector switch.

The substations may be of any suitable or approved type. Those with which I have elected to illustrate my invention are all alike. Substation A, for example, comprises a receiver 2, switch-hook 3, transmitter 4, induction coil 5, ringer 6, condenser 7, impulse wheel 8, impulse springs 9 and 10 and a ringing push button 11. The switch-hook 3 controls the substation circuits through the medium of the cam arm

12. When the receiver is on the hook the arm 12 maintains the spring 14 in contact with the spring 13, thereby bridging the ringer 6 and condenser 7 across the line conductors 16 and 17. When the receiver is removed the hook rises, permitting the spring 14 to disengage the spring 13 and engage the spring 15, thereby closing a bridge consisting of the transmitter 4, primary winding of the induction coil 5 and impulse springs 9 and 10 across the line. The impulse wheel 8 is provided with a number of impulse teeth 18 and is secured to a shaft 19 to which there is also secured a dial (not shown) provided with finger holes. When the impulse wheel is rotated forward by the dial the impulse springs are not operated, but as the impulse wheel returns to normal position the impulse spring 9 is forced out of engagement with the spring 10 a number of times, depending upon the digit called, by the teeth 18. The push button 11, when depressed, serves to remove the short-circuit from the resistance 20. The ringers of the different substations are of the well-known harmonic type—that is, they are adapted to be actuated by ringing current of a certain frequency and not by other frequencies. The ringer of each telephone on a line may be adapted to be rung by a different frequency.

The line switch C is of the general type disclosed in British Patent No. 26,301 of 1906, and in the Western Electrician of Chicago, Illinois, of January 25, 1908, but is modified slightly to operate in a so-called two-wire system, i. e., a system in which no ground connection is required at the substation for operating the central office apparatus. As here represented the line switch C comprises a plunger (not shown) attached to a plunger arm 21 which is adapted to be attracted by the magnet 22. The circuit of the magnet 22 is controlled by the calling subscriber through the medium of the relay 23. A cut-off relay 24 is provided by means of which the switch C may be disconnected from the line. The springs of the relay 24 may also be operated by the plunger arm 21. When the plunger arm 21 is attracted by the magnet 22 the plunger forces the springs 25, 27, 29 and 31 into engagement with the springs 26, 28, 30 and 32, respectively. Although only one set of springs 25, 26, 27, etc., is shown, each line switch is provided with a bank consisting of a number of such groups of springs, each set forming the terminals of a trunk line leading to a selector switch E. Each trunk line is multiplied through the corresponding bank springs of a number of switches C.

The master switch D is a modified form of the master switch shown in the said British patent and the Western Electrician. The master switch comprises essentially a motor magnet 33 for operating the ratchet wheel 34, a bank of contacts comprising a common segment 35 and a number of individual segments *a*, and relays 36 and 37. The ratchet wheel 34 is connected with a so-called plunger shaft, with which latter the plungers of the idle line switches C normally rest in locking engagement. A continued rotary motion of the said wheel gives to the plunger shaft an oscillatory motion to move the idle plungers back and forth in front of the bank of trunk terminals. Secured to the plunger shaft there is a cam 38 having on its surface a number of openings adapted to be engaged by the pin 39 on the armature 40. The openings in the cam 38 are so spaced that the pin 39 may engage one of said openings only when the plungers that are engaged with the plunger shaft are in a position directly in front of a trunk terminal.

The selector switch E is of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, being modified somewhat to operate in a two-wire system. Briefly, the selector comprises a set of wipers 41, 42 and 43 carried upon a shaft having a vertical motion controlled by the vertical magnet 44 and a rotary motion controlled by the rotary magnet 45. The side switch comprising the wipers 46, 47, 48 and 49 is well known and is controlled by the private magnet 50 in the usual manner. The operation of the selector is controlled by the calling subscriber through the medium of the double-wound line relay 51. The relays 52, 53 and 54 deenergize slowly after their energizing circuits have been broken. The slow action may be obtained in several ways, but preferably by securing a heavy copper ring around one end of the core. Means for releasing the selector are provided in the release magnet 55 which is disconnected from the battery by the separation of the off normal springs 56 and 57 as long as the switch shaft is in its normal position. In this instance the mechanism is released immediately upon the energization of the release magnet rather than by its deenergization, as shown in the said selector patent. The selector F is similar to the selector E with the addition of one side switch wiper.

The connector H is of the general type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, being modified, however, to operate in a two-wire system and having means for selecting different current generators. The general features of the connector are very similar to those of the selectors. The connector is provided with a back-bridge relay 58 through which the

line is provided with talking current, and a ringer 59 for connecting the generator with the called line. In the connector the double-wound line relay of the selector is replaced by two single-wound relays 60 and 61. The means whereby different generators may be selected comprises a pair of wipers 62 and 63 attached to a ratchet wheel 64 which is adapted to be rotated by means of the magnet 65. This mechanism may be conveniently mounted upon a plate attached to the upper part of the frame of the switch, as indicated in the detail view, Fig. 3. The wipers 62 and 63 are adapted to engage a number of pairs of contacts, each of which pairs is connected to a ringer generator L, L', $L^2$ or $L^3$. These generators each produce ringing current of a different frequency. For example, the generator L produces the proper frequency for actuating the ringer at substation A, the substation $A^2$ is signaled by the generator L', while the ringer at substation $A^3$ will respond only to current from the generator $L^2$. The wipers 62 and 63 are connected to the springs of the ringer relay 59, so that the frequency of the ringing current which will be projected over the line upon the energization of the said ringer relay depends upon the position of the wipers 62 and 63. Although only four sets of contacts for the wipers 62 and 63 are shown, it is evident that any suitable number may be used. The ratchet wheel 64 is held in its operated position against the tension of a spring (not shown) by the pawl 66. When the release magnet 67 is energized to release the connector it also withdraws the pawl 66, as shown in Fig. 3, to permit the wipers 62 and 63 to be restored to normal position. Secured to the periphery of the wheel 64 is a small bushing which normally holds the spring 68 out of engagement with the spring 67. As soon as the wheel 64 is rotated one or more steps the bushing $68^a$ permits the spring 68 to engage the spring 67.

The apparatus shown at O consists of a relay 69 and a harmonic polarized relay 70 which is similar to the usual harmonic ringer except that no gongs are provided. By a "harmonic relay" is meant a relay that will respond to a current of a certain frequency, but which will not respond to other frequencies appreciably higher or lower. The armature of the relay 70 controls a pair of springs 71 and 72 which control the circuit of the relay 69. From the relay 69 a trunk line leads to an operator's key K. This trunk line may be made common to a number of relays 69.

In order to give a clearer understanding of my invention I will give a complete description of the various operations that take place when one subscriber calls another. It will first be assumed that the subscriber A (Fig. 1) desires to communicate with the substation $A^4$, the number of which will be assumed to be 22201. Since the impulses for the last digit of a number are employed in the connector switch to operate the frequency selector, the first four digits represent the number of the line and the last digit represents the number of the substation on the line. It is thus evident that the numbers of all substations on any particular line will differ only in the last digit.

The removal of the receiver at the substation A preparatory to making a call closes a bridge across the line conductors 16 and 17 through the transmitter 4, one winding of the coil 5 and impulse springs 9 and 10, as previously explained. The closure of this bridge across the line completes a circuit through the line relay 23 of the line switch C. This circuit extends from ground G' through the springs 73 and 74, line 17, thence through substation A and back over the line 16, through the springs 75 and 76, relay 23, contact point 77 and armature 40 to the battery lead 78, thence through battery B to ground G. The relay 23, upon energizing, operates to close a circuit extending from ground $G^2$ through the springs 79 and 80 and magnet 22 to the battery lead 78, thence through battery B to ground G. The magnet 22, upon energizing, operates to thrust the plunger of the line switch into the bank and to separate the springs 75 and 74 from the springs 76 and 73, respectively. This operation of the springs 74 and 75 breaks the circuit of the relay 23, allowing it to deenergize to disconnect the ground $G^2$ from the magnet 22. The magnet 22 does not deenergize when the ground $G^2$ is disconnected, because at the same time a holding circuit is closed through the said magnet as follows: When the line switch plunger forces the bank springs 25 and 31 into contact with the springs 26 and 32, respectively, a circuit is closed through the line relay 51 of the selector E. This circuit extends from ground $G^3$ through the winding 81 of the relay 51, side switch wiper 47, bank springs 32 and 31, thence over the line 17, through substation A and back over the line 16, through springs 25 and 26, relay 83, side switch wiper 46 and winding 82 of the relay 51 to the battery lead 78. The relay 51, upon energizing, operates to close a circuit extending from ground $G^4$ through the springs 84 and 85 and relay 52 to the battery lead 78. The relay 52 energizes upon the closure of this circuit, operating to shift the spring 88 out of engagement with the spring 87 and into engagement with the spring 89, and to close contact between the springs 90 and 91. The engagement of springs 90 and 91 completes a circuit extending from ground $G^5$ through springs 91 and 90 of the relay 52, springs 92 and 93 of the

relay 94, bank springs 28 and 27, cut-off relay 24 and magnet 22 to the battery lead 78. The current flowing over this circuit serves to maintain the magnet 22 energized after the relay 23 has deenergized, as previously stated. The engagement of the springs 90 and 91 of the relay 52 also extends a ground potential from ground $G^5$ to and through the bank springs 28 and 27, as before traced, and thence over conductor 95 to the private bank contact 96 of the connector H (Fig. 2), thence to the corresponding contact in the bank of each connector which has access to the line of the calling substation. This ground potential prevents any other line from obtaining a connection with the calling line over the conductors 191 and 192 while it is busy.

The engagement of the bank springs 29 and 30 of the line switch C closes a circuit extending from ground $G^6$ through said springs, master switch bank contact point 97 which corresponds to the trunk seized by the switch C, wiper 98, segment 35 and relay 36 to the battery lead 78. The relay 36, upon energizing, operates to close a circuit through the relay 37, which in turn attracts its armature 40, which armature unlocks the plunger shaft by withdrawing the pin 39 from the cam 38, and closes a circuit through the motor magnet 33 and interrupter springs 99.

Since the motor magnet circuit includes the interrupter springs 99, the said magnet operates in a manner similar to that of a buzzer as long as the armature 40 engages the contact point 100. The continued operation of the magnet 33 serves to rotate the ratchet wheel 34 step by step to move the plungers that are locked with the plunger shaft away from the trunk occupied by the switch C toward the next one. After the plunger shaft has been moved a short distance the wiper 98 leaves the contact 97, allowing the relays 36 and 37 to be deenergized. The armature of the relay 37 cannot fall back immediately upon the deenergization of the relay, because the opening in the cam 38 which was engaged by the pin 39 has been moved out of register therewith. The motor magnet 33 will continue to operate to advance the idle plungers until the next opening in the cam 38 passes under the pin 39, whereupon the armature 40 falls back, locking the shaft against further rotation and breaking the operating circuit of the magnet 33. If the next trunk after the one just seized had been busy the wiper 98 would have found a ground potential upon the next contact after the contact 97, and consequently the relays 36 and 37 would have remained energized while the next opening was passing under the pin 39 and the idle plungers would have been carried past the busy trunk to an idle one. It is evident that as long as the master switch D is operating, the armature 40 is disengaged from the contact point 77, thus disconnecting the battery from the relay 23 of all line switches C which are controlled by the master switch. This precaution prevents any line switch from being operated while its plunger is being moved from one trunk to another.

The foregoing is the condition of the central office apparatus immediately after the receiver is removed from the switch-hook at the calling substation. The operation of the substation calling device for the first digit 2 twice momentarily forces the spring 9 out of engagement with the spring 10, each time breaking the circuit of the line relay 51 of the selector E. The trunk relay 83 which, it will be remembered, was included in the circuit of the selector line relay 51 is operated by the impulses, but has no utility except when the calling and called substations are on the same line, as will be explained later. Each time the line relay 51 of the selector deenergizes in response to the impulses from the substation it permits the spring 84 to disengage the spring 85 and to engage the spring 86. Since the relay 52 is slow acting it does not have time to deenergize during the momentary interruption of its circuit at the springs 84 and 85; consequently the engagement of the springs 84 and 86 closes a circuit through the vertical magnet 44. This circuit extends from ground $G^4$ through the springs 84 and 86, 88 and 89, private magnet relay 54, vertical magnet 44 and side switch wiper 48 to the battery lead 78. The vertical magnet receives two impulses over this circuit, operating to raise the switch shaft and wipers 41, 42 and 43 two steps to a position opposite the second row or level of bank contacts. The private magnet relay 54, which is included in the energizing circuit of the vertical magnet, is energized by the first impulse; but, being a slow-acting relay, does not have time to deenergize during the momentary interruption of its circuit between impulses. In its operated position the relay 54 closes a circuit extending from ground $G^4$ through the springs 101 and $101^a$ and private magnet 50 to the battery lead 78. Shortly after the last impulse is delivered to the vertical magnet the relay 54 deenergizes, breaking the circuit of the private magnet 50, which in turn deenergizes, permitting the side switch to pass from first to second position. The passage of the side switch wiper 48 from first to second position disconnects the battery from the vertical magnet 44 and closes a circuit through the rotary magnet 45. This circuit extends from ground $G^3$ through the interrupter springs 102, rotary magnet 45, relay 53 and side switch wiper 48 to the battery lead 78. The rotary magnet 45, upon energizing, attracts its armature, which operates to rotate the

wipers one step, presses down the armature of the private magnet 50, and opens the circuit of its own magnet at the interrupter springs 102. The armature of the rotary magnet thereupon falls back and, if the trunk line upon the terminals of which the wipers have just been rotated is idle, the armature of the private magnet falls back also, permitting the side switch to pass to third position. If the first trunk of the second level is busy, however, the private wiper 43 finds the first private bank contact grounded in a manner to be explained later. The engagement of the wiper 43 with a grounded contact completes a circuit extending through the side switch wiper 49, contact point 103 and private magnet 50 to the battery lead 78. The private magnet is energized by current flowing over this circuit and prevents the side switch from passing to third position when the rotary armature falls back. With the side switch thus locked in second position the rotary magnet will continue to advance the wipers step by step until the private wiper 43 engages a non-grounded contact of an idle trunk, whereupon the private magnet 50 deenergizes and permits the side switch to pass into third position. The movement of the side switch wiper 48 from second position breaks the circuit of the rotary magnet 45, and the wipers 46 and 47 extend the line connection through the shaft wipers 41 and 42 to the second selector F.

Upon the completion of the connection to the second selector the line relay 104 and release relay 105 are energized in the same manner in which the corresponding relays of the selector E were first energized. The relay 105, upon energizing, provides a guarding ground potential at the first selector private bank contacts of the seized trunk, and closes a holding circuit through the relay 52 of the selector E. This circuit extends from ground $G^8$ through the side switch wiper 106 and springs 108 and 107 to the private bank contact 109 and to the corresponding contact in the bank of each selector which has access to the trunk leading to the selector F. From the bank contact 109 the circuit extends through the wiper 43, side switch wiper 49 (in third position), springs 110 and 111 and release relay 52. This circuit is closed before the relay 52 has time to deenergize after its former circuit is broken by the deenergization of the relay 51. During the short interval that elapses between the time the side switch of the selector E passes to third position and the time the relay 105 of the selector F energizes, the seized trunk is protected by a ground potential extending from ground $G^7$ through the springs of the guarding relay 53 at the selector E. The relay 53 is energized in series with the rotary magnet 45 and remains energized for an instant after the wipers have been rotated the last step.

The selector F responds to the operation of the substation calling device for the second digit 2, operating in the same manner as explained for the first selector E to extend the connection to an idle trunk line leading to a connector switch H. Upon completion of the connection with the connector H the relays 60 and 61 are both energized, closing a circuit extending from ground $G^9$ through the springs 112 and 113 of the relay 61, and from ground $G^{10}$ through the springs 114 and 115 of the relay 60, thence through the springs 116 and 117 of the back-bridge relay 58 and through the release relay 118 to the battery lead 78. The relay 118, upon energizing, provides a guarding potential for the seized trunk and provides a holding circuit for the release relays of the selector switches. This circuit extends from ground $G^9$ through the side switch wiper 119, springs 120 and 121, conductor 122, private bank contact and wiper 125, side switch 126, springs 127 and 128 to the conductor $128^a$, from which latter one branch passes through the relay 105, while another branch passes through the side switch wiper 106 to the relay 52 of the selector E over a circuit which has been previously traced.

The connector H is now in position to receive impulses for the remaining digits of the desired number. When the calling device is operated for the third digit 2 the bridge across the calling line is again opened twice, allowing the relay 60 to twice momentarily be restored to normal position. Each time the relay 60 deenergizes it closes a circuit through the vertical magnet 130. This circuit extends from ground $G^{10}$ through the springs 114 and 131, 132 and 139, private magnet relay 133, vertical magnet 130 and side switch wiper 134 to the battery lead 78. The vertical magnet receives two impulses over the circuit just traced, operating to raise the wipers two steps. The private magnet relay 133 is energized by the first impulse and remains in its operated position until all the impulses are delivered to the vertical magnet. In its operated position, besides closing the circuit of the private magnet 135, the relay 133 short circuits the relay 61 by the engagement of the springs 136 and 137. This short-circuiting of the relay 61 is for the purpose of decreasing the resistance of the circuit of the relay 60 while it is operating. The deenergization of the private magnet relay 133 after all the impulses have been delivered to the vertical magnet breaks the circuit of the private magnet 135, which then operates to cause the side switch to pass from first to second position. The passage of the side switch

wiper 134 from first to second position shifts the battery connection from the vertical magnet 130 to the rotary magnet 138. Each time the line relay 60 deenergizes in response to the impulses for the fourth digit 0 a circuit is closed through the rotary magnet 138. This circuit extends from ground $G^{10}$ through the springs 114 and 131, 132 and 139, private magnet relay 133, springs 140 and 141 of the relay 142, rotary magnet 138 and side switch wiper 134 to the battery lead 78. The private magnet relay 133 operates, in the manner already explained, to close the circuit of the private magnet 135 as long as the impulses are being delivered to the rotary magnet. After the last impulse is delivered the relay 133 deenergizes and opens the circuit of the private magnet 135. If the called line is idle the private magnet thereupon deenergizes to permit the side switch to pass to third position. If the called line is busy, however, the side switch remains in second position and the calling substation is given the busy signal in the following manner: Whenever a line is busy there is a guarding ground potential established at the connector private bank contacts of that line. Consequently, when the private wiper 143 is rotated onto the contacts of a busy line the ground potential is extended from the guarded private bank contact through the side switch wiper 147 and springs 148 and 149 and winding of the relay 142 to the spring 146 of the private magnet relay 135. When the relay 133 deenergizes, the spring 145 engages the spring 146 before it disengages the spring 137. Thus the private magnet remains energized by the ground extending from the private bank contact of the busy line through the relay 142, and at the same time the said relay 142 also becomes energized over the same circuit. The relay 142, upon energizing shifts the spring 149 into engagement with the spring 150, whereby the holding ground of the relay 142 and private magnet 135 is transferred from the private bank contact to ground $G^9$, the circuit extending from the side switch wiper 119 and springs 120 and 121. Since the private magnet was not deenergized after the impulses were delivered to the rotary magnet, the side switch did not leave second position and the calling substation is given the busy signal over a circuit extending from the battery lead 78 through the secondary winding of the induction-coil of the busy signaling machine M, through the private magnet springs 151 and 152, ringer relay springs 154 and 155, condenser 156, thence over the heavy conductors shown in Fig. 1 to and through the substation A and back through the relay 60 of the connector H to the starting point. The calling substation will continue to receive the busy signal until the receiver is restored to the switch hook, when the central office apparatus will be released in a manner to be explained. It is evident that when the connector H is thus locked on a busy line the springs 140 and 141 of the relay 142 are separated, thus preventing the operation of the rotary magnet 138 when the last digit is called.

The foregoing is an explanation of how the busy signal is received in case the called line is busy; but in the drawings it is assumed that the line was idle when called. When the private magnet relay 133 deenergizes after the wipers have been rotated onto an idle line, the circuit of the private magnet is broken. The private magnet thereupon deenergizes, allowing the side switch to pass from second to third position. The side switch wipers 153 and 157 (in third position) extend the line conection through the shaft wipers 158 and 159 to the line of the called substation. The side switch wiper 147 (in third position) provides a guarding ground for the connector private bank contacts of the called line and closes a circuit through the cut-off relay 160 of the line switch C'. This potential and circuit extend from ground $G^{11}$ through the side switch wiper 147, shaft private wiper 143 to the bank contact 161, and thence to the corresponding contact in the bank of each of the connectors which have access to the line #2220. From the bank contact 161 the circuit also extends through the relay 160 and magnet 162 to the battery lead 78. The relay 160, upon energizing, operates to disconnect the line switch C' from the line. Although the current flowing through the relay 160 and magnet 162 in series would be strong enough to hold down the armature of the magnet 162 if it were already operated, it is not strong enough to attract it from its normal position. The engagement of the side switch wiper 134 with its third-position contact point connects the operating magnet 65 of the frequency selecting mechanism with the battery lead 78, thus placing the magnet 65 in position to be operated for the last digit.

The operation of the substation calling device for the last digit 1 causes the operation of the connector line relay 60 in the same manner as for the two previous digits. Each time the relay 60 deenergizes for this digit it closes a circuit extending from ground $G^{10}$ through the springs 114 and 131, 132 and 139, private magnet relay 133, magnet 65 and side switch wiper 134 to the battery lead 78. Each time the magnet 65 is energized the wipers 62 and 63 are rotated one step. Since in this instance the last digit is 1, the wipers are rotated onto the terminals of the generator L, which is assumed to be of the proper frequency to ring the bells at substation $A^4$. As soon as the private magnet relay 133 de-

energizes after all the impulses for the last digit are delivered, the ringer relay 59 begins to be intermittently energized over a circuit extending from ground $G^{12}$ through the interrupter 163, springs 164 and 165 of the relay 58, relay 59, springs 166 and 167 of the relay 133, and through the springs 67 and 68 and side switch wiper 134 to the battery lead 78. Although the springs 67 and 68 engage as soon as the ratchet wheel 64 is moved one step, the circuit of the ringer relay 59 is not completed until the relay 133 deenergizes to permit the springs 166 and 167 to engage. The private magnet 135 is energized and deenergized once in the usual manner for the last digit; but since the side switch has already reached the limit of its travel, this operation of the private magnet has no effect.

Each time the ringer relay 59 is energized, as above explained, the calling and called lines are disconnected and the generator L is bridged across the called line. The path of the ringing current extends from one terminal of the generator L through the wiper 63, ringer relay springs $168^a$ and 154, side switch wiper 153, shaft wiper 159, line conductor 169, thence through the ringer 170 of the substation $A^4$ and back over the line 171, through the shaft wiper 158, side switch wiper 157, ringer relay springs 173 and 172, and through the wiper 62 to the opposite terminal of the generator L. This ringing current also passes through the harmonic relay 70 of the device O, but is not of the proper frequency to operate it.

When the receiver at the substation $A^4$ is removed, or as soon thereafter as the ringer relay 59 is deenergized, if it happens to be energized at the time, the called substation is provided with talking battery current. The circuit of this current extends from ground $G^{11}$ through the side switch wiper 147, lower winding of the back-bridge relay 58, ringer relay springs 155 and 154, side switch wiper 153, shaft wiper 159, line 169, thence through the impulse springs, primary winding of the induction-coil and transmitter at the substation $A^4$, and back over the line 171 through the shaft wiper 158, side switch wiper 157, ringer relay springs 173 and 168 and upper winding of the relay 58 to the battery lead 78. The back-bridge relay 58, which is included in this circuit, is energized and, by separating the springs 164 and 165, prevents further energization of the ringer relay after the called subscriber has answered. An uninterrupted conversation may now be carried on between the two connected substations over the heavy conductors shown in the drawings.

After the conversation is completed the release of the central office switches is initiated by the restoration of the receiver to the switch-hook at the calling substation. The separation of the springs 15 and 14 by the restoration of the receiver at the substation A destroys the circuits of the relays 60 and 61 of the connector H. These relays, upon deenergizing, break the holding circuits of the release relays 118, 105 and 52 of the switches H, F and E, respectively. The release relays, upon deenergizing, operate to close the circuits of their respective release magnets. The circuit of the release magnet 67 of the connector H extends from ground $G^{10}$ through the springs 114 and 131 of the relay 60, springs 132 and 174 of the relay 118, magnet 67 and off normal springs 175 and 176 to the battery lead 78. The magnet 67, upon energizing, not only allows the side switch and shaft to be restored to normal position, but withdraws the pawl 66 from the wheel 64 to allow the wipers 62 and 63 to be released. The selectors F and E are released in the same manner as the connector H. The deenergization of the release relay 52 of the selector E also breaks the holding circuit of the magnet 22 of the line switch C, allowing its plunger to be withdrawn from the bank, and all the apparatus employed in the connection is left in readiness for another call.

When a substation has been disconnected from a party-line or changed to another line and it is desired that any one calling for this disconnected number shall be notified of the fact, the device shown at O is connected to the line at the central office. In the present instance it is assumed that the substation #22202 has been disconnected from line #2220 and the device O substituted therefor. Any one calling substation #22202 will obtain connection with the line #2220 in the same manner as previously described, after which the frequency-selecting wipers 62 and 63 will be rotated two steps onto the terminals of the generator L′. It is understood, of course, that the harmonic relay 70 at the device O must be adapted to respond to ringing current of the same frequency as was required to ring the bells at substation #22202, and that the generator L′ will supply current of such frequency. The relay 70 responds as soon as current is projected over the line from the generator L′ and draws its armature down first on one side and then on the other. When the armature of the relay 70 is drawn to the right the spring 71 engages the spring 72, closing a circuit extending from the ground $G^{11}$ at the connector H to the private wiper 143, as previously traced, thence over the conductor 180 and through the relay 69 and contacts 72 and 71 to the battery B. The relay 69 thereupon energizes and closes a locking circuit for itself through the springs 181 and 182. The engagement of the springs 183 and 185 with the springs 184 and 186 bridges the relay

187 across the line conductors 171 and 169, causing the back-bridge relay 58 of the connector to be energized to cut off the ringing current in the same manner as when the receiver was removed at the substation A⁴. The relay 187 is also energized in series with the relay 58, and operates to close a circuit through the lamp 188 which signifies to the operator that some one is calling substation #22202. By throwing the key K the operator may connect her talking set with the line to notify the calling subscriber that the substation desired has been disconnected from that line. The relay 69 will be unlocked by the disengagement of the private wiper 143 from the contact 161 upon the release of the connector H.

In case the called substation is on the same line as the calling substation the operation of obtaining a connection is the same as described, except that the push-button must be pressed to signal the called subscriber. If the subscriber A (#22301) had called substation A′ (#22302) the operation of the central office apparatus would have been the same as when calling substation #22202 except that the connector wipers would have been brought into engagement with the contacts 189, 190 and 96, thus being connected back to the calling line over conductors 191 and 192. As has been previously mentioned, a guarding ground is established at the connector bank contact 96 as soon as the line switch C is operated. In order to permit the connector H to complete connection with the calling line this ground potential must be removed or modified for a short time after the connector wipers have been placed in contact with the line terminals. It is the function of the relays 83 and 94, which are associated with the trunk leading to the selector E, to so modify this potential at the private bank contact 96 that the connector may complete connection with the calling line. As previously mentioned, the relay 83 deenergizes each time the substation impulse springs are separated when the calling device is operated. Each time the relay 83 deenergizes, a circuit is closed extending from the ground G⁵ at the selector E through the springs 91 and 90, 193 and 194, and through the relay 94 to the battery lead 78. The relay 94, upon energizing, separates springs 92 and 93, thereby removing the short-circuit from the resistance 195. The relay 94 is slow acting and consequently remains energized for a short time after the last impulse for any digit is transmitted. It is thus evident that the circuit which tends to lock the private magnet 135 after the digit 0 of the number 22302 is called extends from ground G⁵ at the selector E through the springs 91 and 90, resistance 195, bank springs 28 and 27, and over conductor 95 to the connector bank contact 96 (Fig. 2), thence through wiper 143, side switch wiper 147, springs 148 and 149, relay 142, springs 146 and 145 and through the private magnet 135 to the battery lead 78. Since this circuit contains the resistance 195, sufficient current does not flow to lock the magnet 135, hence the side switch passes to third position in the usual manner. After the side switch has had time to reach third position the relay 94 deenergizes, again short-circuiting the resistance 195 and thus again connecting the contact 96 to ground without interposed resistance. It should be stated that although the resistance 195 prevents sufficient current from flowing to lock the private magnet of the connector, it does not reduce the current through the magnet 22 of the line switch C sufficiently to allow it to release its plunger. Also, it is evident that the trunk relay 94 must be slower than the private magnet relay 133 of the connector switch.

It is evident that when connection is completed back to the calling line by the connector K the bridge across that line through the calling substation will cause the back-bridge relay 58 of the connector to be energized so as to open the circuit of the ringer relay 59 in the same manner as when the receiver at the called substation A⁴ was removed. In order to ring the substation #22302 the subscriber at substation A must press the button 11. The pressing of the button 11 removes the short-circuit of the resistance 20, which is then included in the bridge across the line conductors 16 and 17. This increase of resistance reduces the current through the back-bridge relay 58 sufficiently to allow its armature to fall back while the line relay 60 still receives enough current to hold its armature in its operated position. The deenergization of the relay 58 allows the ringer relay to be intermittently energized, in the same manner as when the substation A⁴ was called, until the button 11 is released or the receiver at the called substation is removed. During the time the relay 59 is energized to connect the ringing generator with the line a circuit is closed extending from ground G¹³ through the ringer relay springs 172 and 173, side switch wiper 157, shaft wiper 158, bank contact 189, thence over the conductor 191 to the line switch C and back over the upper heavy conductors, through the switches E and F and through the relay 60 of the connector H to the battery lead 78. The closure of this circuit through the relay 60 is for the purpose of preventing it from chattering to the action of the ringing current.

The switches are released from this connection as in the previous case, but not, however, until the last subscriber has hung up his receiver.

From the foregoing it will be seen that

I provide a two-wire system in which the subscribers on a party-line are selectively signaled. For the purpose of this application the expression "two-wire system" means one in which the automatic switches are controlled over the two sides of the calling line in series, and in which no operating grounds are employed at the sub-stations. It will also be seen that I provide a two-wire system in which connectors are provided that are adapted to find the called lines, even though the called line be also the calling line, which is always the case when one party-line subscriber calls another on the same line. Again, it will be seen that I provide a party-line system in which the operator will be signaled whenever a party-line subscriber's line is called whose telephone has been removed or discontinued. The remaining subscribers on the party-line will, however, be called in the regular way and without signaling the operator. This can be done in various ways without departing from the spirit of my invention. As shown, I provide the operator with a tuned or harmonic signal which is only responsive to the signaling current formerly used for the ringer of the subscriber whose telephone has been taken out or discontinued. In this way the ringing currents used on the same line for signaling the other subscribers will not affect the signal at the manual switchboard, and the operator will not be signaled.

What I claim as my invention is:—

1. In a telephone system, a called line, a plurality of substations on said line, an automatic connector switch for finding said line, a line leading to said connector, means for controlling said connector over two sides of said line circuit in series, a ringer relay, a slow-acting relay and a frequency selecting apparatus for said switch, and means controlled by said selecting apparatus and said slow-acting relay for controlling the circuit of said ringer relay.

2. In a telephone system, a plurality of lines divided into groups, a plurality of substations on said lines, an automatic connector having motion in one plane to select a group and motion in a plane at right-angles thereto to find a line in the selected group, a line leading to said connector, means for controlling said connector over two sides of said line circuit in series, a ringer relay, a slow-acting relay and a frequency selecting apparatus for said switch, and means controlled by said selecting apparatus and said slow-acting relay for controlling the circuit of said ringer relay.

3. In a telephone system, a called line, a plurality of substations on said line, an automatic connector switch for finding said line, a line leading to said connector, a ringer relay, a slow-acting relay and a frequency selecting apparatus for said switch, and means controlled by said selecting apparatus and said slow-acting relay for controlling the circuit of said ringer relay.

4. In a telephone system, a plurality of lines divided into groups, a plurality of substations on said lines, an automatic connector switch having motion in one plane to select a group and motion in a plane at right-angles thereto to find a line in the selected group, a line leading to said switch, a ringer relay, a slow-acting relay and a frequency selecting apparatus for said switch, and means controlled by said selecting apparatus and said slow-acting relay for controlling the circuit of said ringer relay.

5. In a telephone system, a subscriber's line, a plurality of substations on said line, a connector switch for finding said line, a line circuit leading to said switch, means for controlling said switch over two sides of said line circuit in series, a frequency selecting apparatus, and a release magnet for causing the release of both said connector and frequency selector.

6. In a telephone system, a plurality of lines divided into groups, a plurality of substations on said lines, an automatic connector having motion in one plane to select a group and motion in a plane at right-angles thereto to find a line in the selected group, a line circuit leading to said switch, means for controlling said switch over two sides of said line circuit in series, a frequency selecting apparatus, and a release magnet for causing the release of both said connector and frequency selector.

7. In a telephone system, a line, a plurality of substations on said line, means for selectively signaling the subscribers on said line, and a manual switchboard provided with means for receiving the signal when the call is for a subscriber whose telephone has been taken out or discontinued.

8. In a telephone system, a line, a plurality of substations on said line, means for selectively signaling the subscribers on said line, and a manual switchboard provided with a signal which is responsive only when one of said selective signaling devices is operated.

9. In a telephone system, a line, a plurality of substations on said line, means for selectively signaling the subscribers on said line, and an operator's signal which is responsive only when a particular one of said selective signaling devices is operated.

10. In a telephone system, a line, a plurality of substations on said line, means for automatically extending a call to said line, means for signaling the subscribers on said line, and an operator's signal responsive only when the call is for a subscriber whose telephone has been taken out or discontinued.

11. In a telephone system, a line, a plu-

rality of substations on said line, means for selectively signaling the subscribers on said line, an operator's signal corresponding to one of the substations on said line, and means including an electromagnet for controlling said operator's signal, said electromagnet provided with an armature which is tuned and thereby rendered responsive only when the selective signaling device is operated which corresponds to the said operator's signal.

12. In a telephone system, a line, a plurality of substations on said line, a connector switch, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a circuit for providing a guarding potential for said line, a normally short-circuited resistance included in said circuit, and means for removing said short-circuit so as to temporarily reduce the current passing through said guarding circuit so as to permit said connector to connect with the line.

13. In a telephone system, a line, a plurality of substations on said line, a connector switch, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a circuit for providing a guarding potential for said line, a normally short-circuited resistance included in said circuit, a slow-acting relay for controlling said short-circuit, and means for energizing said relay so as to open said short-circuit to permit said connector to connect with the line.

14. In a telephone system, a line, a plurality of substations on said line, a connector switch, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a circuit for providing a guarding potential for said line, a normally short-circuited resistance included in said circuit, a slow-acting relay for controlling said short-circuit, means for energizing said relay so as to open said short-circuit to permit said connector to connect with the line, and a second relay included in series in the talking circuit for controlling said slow-acting relay.

15. In a telephone system, a line, a plurality of substations on said line, a connector switch controllable over two sides of said line in series, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a circuit for providing a guarding potential for said line, a normally short-circuited resistance included in said circuit, and means for removing said short-circuit so as to temporarily reduce the current passing through said guarding circuit so as to permit the connector to connect with the line.

16. In a telephone system, a line, a plurality of substations on said line, a connector switch controllable over two sides of said line in series, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a circuit for providing a guarding potential for said line, a normally short-circuited resistance included in said circuit, a slow-acting relay for controlling said short-circuit, and means for energizing said relay so as to open said short-circuit to permit said connector to connect with the line.

17. In a telephone system, a line, a plurality of substations on said line, a connector switch controllable over two sides of said line in series, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a circuit for providing a guarding potential for said line, a normally short-circuited resistance included in said circuit, a slow-acting relay for controlling said short-circuit, means for energizing said relay so as to open said short-circuit to permit said connector to connect with the line, and a second relay included in series in the talking circuit for controlling said slow-acting relay.

18. In a telephone system, a line, a plurality of substations on said line, signals for said substations, a manual switchboard provided with a signal, and automatic progressively movable trunking apparatus for selectively signaling either the operator at said switchboard or the subscribers on said line, all of said signals being connected to said line.

19. In a telephone system, a line, a plurality of substations on said line, an operator's signal on said line, means for selectively signaling either the operator or the subscribers over said line.

20. In a telephone system, a party line, a progressively movable switch for extending a connection therefrom, means for placing a guarding potential on said line by operating said switch when one subscriber on said line initiates a call, and means for ringing back on said line without removing said guarding potential.

21. In a telephone system, a plurality of lines, an automatic switch adapted to establish connection with one of said lines, means for extending connection to said switch, an operator's board, and means for automatically switching said connection from said switch to said board after connection is established with said line.

22. In a telephone system, a two-conductor line, a plurality of stations connected thereto,

means for signaling a station on said line, a relay for controlling the application of said signaling means, a second relay, said second relay connected to a conductor of said line, a trunk line extending to a manual switchboard, a signal for said trunk line, a calling line, a battery for operating and talking purposes, a third relay for connecting a pole of said battery over said conductor to energize said second relay, whereby when the calling line signals for a station on said first line, the service of which has been discontinued, the calling line is connected to the manual switchboard over said trunk line.

23. In a telephone system, a two-conductor line, a plurality of stations connected thereto, means for signaling a station on said line, said signaling means comprising a circuit, a relay for controlling said circuit, a second relay, said second relay connected to a conductor of said line, a trunk line extending to a manual switchboard, a signal for said trunk line, a calling line, a battery for operating and talking purposes, a third relay for connecting a pole of said battery over said conductor to energize said second relay, whereby when the calling line signals for a station on said first line, the service of which has been discontinued, the calling line is connected to the manual switchboard over said trunk line.

24. In a telephone system, a line terminating in the exchange or central office, a plurality of subscribers' stations connected with said line, a plurality of ringing current generators of different character, means for applying said generators to said line to signal the stations thereon, a trunk line extending to a manual switchboard, a signal for said trunk line, a relay connected to said first line when a station thereon is out of service or disconnected, means whereby calls for the remaining stations are received at the respective stations and means including said relay whereby calls for the disconnected station are connected via said trunk line to said manual switchboard, and means for operating said signal.

25. In a telephone system, a line terminating in the exchange or central office, a plurality of subscribers' stations connected with said line, a plurality of ringing current generators of different character, means for applying said generators to said line to signal the stations thereon, a trunk line extending to a manual switchboard, a signal for said trunk line, a station of said line disconnected therefrom or out of service, means whereby calls for said disconnected station are connected via said trunk line to said manual switchboard to display said signal, and means whereby calls for the remaining stations on said line are received at the respective stations.

26. In a telephone system, a line terminating in the exchange or central office, a plurality of subscribers' stations connected with said line, a plurality of ringing current generators of different character, means for applying said generators to said line to signal the stations thereon, a trunk line extending to a manual switchboard, a signal for said trunk line, a plurality of stations of said line disconnected therefrom or out of service, means whereby calls for said disconnected stations are connected via said trunk line to said manual switchboard to display said signal, and means whereby calls for the remaining stations on said line are received at the respective stations.

27. In a telephone system, a two-conductor line, a plurality of stations connected to said line, a terminal for said line in the exchange or central office, a ringing current generator for signaling one of said stations, a calling line, a manual switchboard, a battery for operating purposes, a relay for connecting a pole of said battery to a conductor of said line and means responsive to said battery connection whereby when the calling line signals for a station on said first line, the service of which has been discontinued, the calling line is connected to the manual switchboard.

28. In a telephone system, a two-conductor line, a plurality of stations connected to said line, a terminal for said line in the exchange or central office, a ringing current generator for signaling one of said stations, a calling line, a manual switchboard, a battery for operating purposes, a relay for connecting a pole of said battery to a conductor of said line and means responsive to said battery connection whereby when the calling line signals for a station on said first line, the service of which has been discontinued, the calling line is connected to the manual switchboard, a signal at said switchboard, and means for operating said signal.

29. In a telephone system, a plurality of party lines each having substation signals responsive to signaling currents of different character, sources of signaling current of different character, a calling line, a connector switch accessible to said calling line for extending connections to said lines, means in said connector for selectively associating said sources with a called line in accordance with a called number, a trunk to an operator's position, and means associated with said connector for connecting the calling line with said trunk should the substation corresponding to the called number be disconnected.

30. In a telephone system, a party line and a plurality of substations in bridge thereof, each substation having a signal responsive to a particular character of ringing current, different sources of ringing current corresponding to said signals, a calling line, a

connector switch for extending said calling line to said party line, means in said connector for connecting a particular source of ringing current with said party line to signal a wanted substation, a trunk extending to an operator's position, and means associated with said connector for extending the calling line to said trunk should the wanted substation be disconnected from the line.

31. In a telephone system, a party line, a connector switch controllable from the said line to connect with the said line or other lines, a test terminal for said line accessible to said connector, means for placing a guarding potential on said terminal when the line is calling, and means for temporarily reducing said guarding potential without entirely removing the same to permit said connector to connect with said line when one party on the line calls another party on the same line.

32. In a telephone system, a party line, a connector switch controllable from the said line to connect with the said line or other lines, a test terminal for said line accessible to said connector, means for placing a guarding potential on said terminal when the line is calling, and means for temporarily lowering said guarding potential without entirely removing the same in order to render the said potential ineffective to prevent said connector from connecting with said line when one party on the line calls another party on the same line.

33. In a telephone system, a party line, a connector switch controllable from the said line to connect with said line or other lines, a test terminal for said line accessible to said connector, means for connecting said test terminal to one pole of the exchange battery to place a guarding potential thereon when the line is calling, and means for substituting for said potential a potential different from the potential of either pole of the battery in order to permit said connector to connect with said line when one party on the line is calling another party on the same line.

34. In a telephone system, a party line, a connector switch controllable from the said line to connect with said line or other lines, a test terminal for said line accessible to said connector, means for connecting a guarding ground potential to said terminal when the line is calling, and means for reducing said gound potential to a value greater than zero to permit said connector to connect with said line when one party on the line is calling another party on the same line.

35. In a telephone system, a party line, a connector switch controllable from the said line to connect with said line or other lines, a test terminal for said line accessible to said connector, a cut off relay for said line connected to said test terminal, means for placing a guarding potential on said test contact when the line is calling in order to make the line busy and to energize said cut off relay, and means for temporarily reducing said guarding potential sufficiently to permit said connector to connect with said line when one party on the line calls another party on the same line but not sufficiently to permit said cut off relay to deenergize.

36. In a telephone system, a party line, a connector switch controllable from the said line to connect with said line or other lines, a test terminal for said line accessible to said connector, a cut off relay for said line connected to said test terminal, means for placing a guarding potential on said test contact when the line is calling in order to make the line busy and to energize said cut off relay, and means for changing said guarding potential to a value sufficient to maintain said cut off relay energized but insufficient to prevent said connector from connecting with said line when one party on the line calls another party on the same line.

37. In a telephone system, a party line, a partially established reverting connection including a switch individual to said line, a selector, and a final connector, a grounded release trunk conductor extending back to the line switch from said selector for maintaining the line switch in operated position, a test conductor connected to said release trunk conductor at said line switch and to a test contact at said connector switch, and means for reducing the ground potential on said release trunk conductor sufficiently to permit said connector to connect with said line when it is operated to complete the said connection but insufficiently to permit said line switch to release.

38. In a telephone system, a party line, a partially established reverting connection including a switch individal to said line, a selector, and a final connector, a grounded release trunk conductor extending back to the line switch from said selector for maintaining the line switch in operated position, a test conductor connected to said release trunk conductor at said line switch and to a test contact at said connector switch, and means for inserting a resistance in the said release trunk conductor to reduce the potential on said test contact sufficiently to permit said connector to connect with said line when it is operated to complete the said connection while maintaining sufficient current flow to prevent the release of said line switch.

39. In a selective ringing telephone system, the combination, with a connector switch and means for operating it to connect with a party line, of an auxiliary ringing current selecting switch individual to said connector, a motor magnet for operating said selecting switch to select the proper ringing current to selectively signal a desired

station on said party line, a ringing relay for applying the selected ringing current to the line, a slow acting relay in circuit with said motor magnet and maintained energized while the same is being operated, off normal contacts closed by said selecting switch at the beginning of its selecting operation, a circuit for said ringing relay prepared by the closure of said off normal contacts, and contacts for completing said circuit closed by said slow acting relay when the same deenergizes at the close of the selecting operation.

Signed by me at Chicago, Cook County, Illinois, this 18 day of February, 1910.

TALBOT G. MARTIN.

Witnesses:
EDWARD D. FALES,
ARTHUR J. RAY.