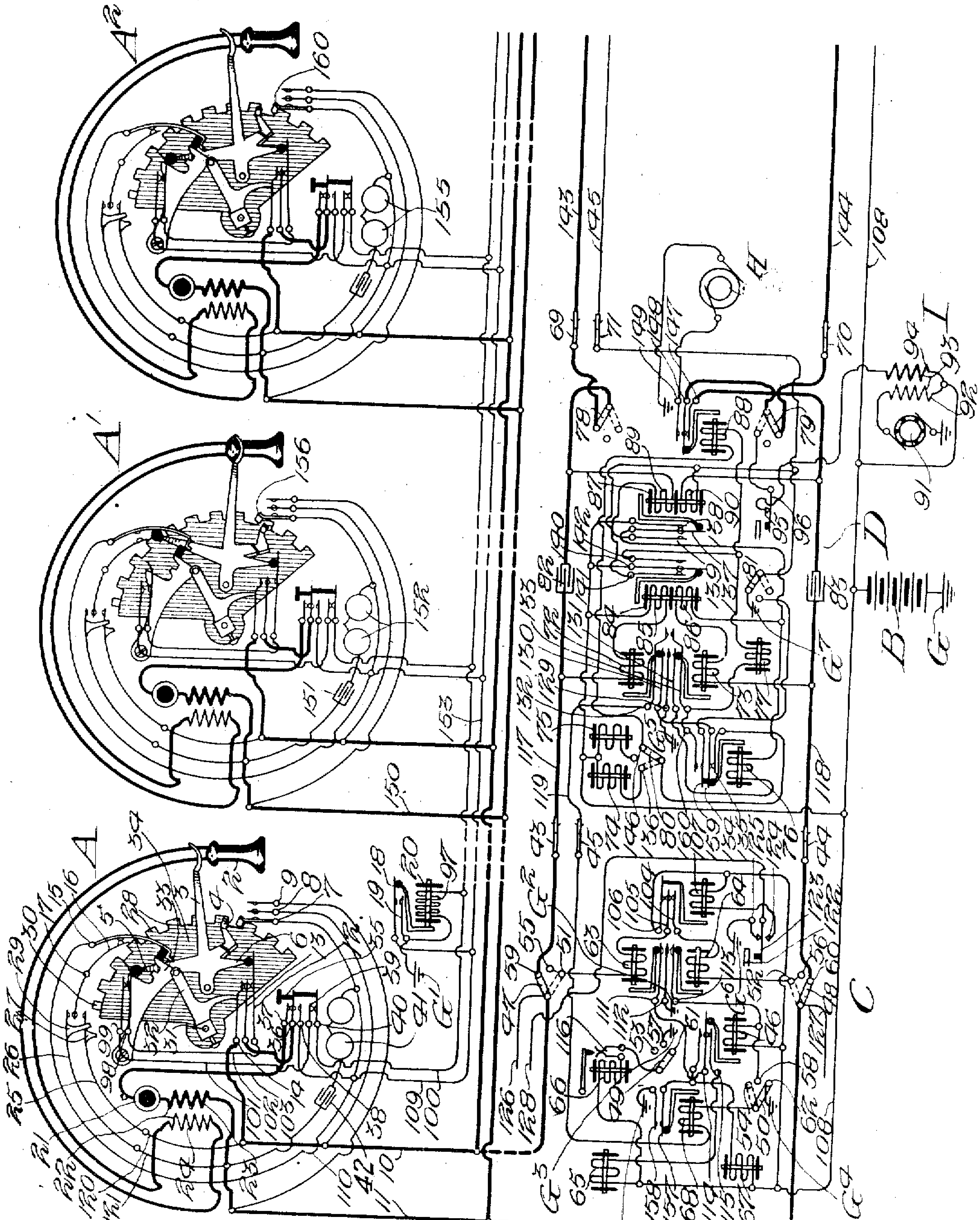
L. KELLER.

NON-INTERFERING EXTENSION OR PARTY LINE TELEPHONE SYSTEM.

APPLICATION FILED JUNE 16, 1908.

1,113,649. Patented Oct. 13, 1914.



Witnesses

A. Andersen.

Edward S. Fales.

Inventor:

Leo Keller,

By Bulkley, Durand & Drury,

Attorneys

UNITED STATES PATENT OFFICE.

LEO KELLER, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

NON-INTERFERING EXTENSION OR PARTY-LINE TELEPHONE SYSTEM.

1,113,649. Specification of Letters Patent. Patented Oct. 13, 1914.

Application filed June 16, 1908. Serial No. 438,750.

To all whom it may concern:

Be it known that I, LEO KELLER, a citizen of the United States of America, and resident of Los Angeles, Los Angeles county, California, have invented a certain new and useful Improvement in Non-Interfering Extension or Party-Line Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems of that particular kind in which several telephones are connected with one and the same line, and in which provision is made for locking out the other subscribers when one subscriber is in possession of the line. Prior to my invention it has been proposed to employ a relay common to the different telephones on the line, and to provide means for energizing this relay whenever any subscriber is using the line, and to thereby disconnect the ground and thus preclude the other subscribers from interfering with the desired use of the line by the subscriber first obtaining possession thereof. In such case, however, the said relay not only controlled the ground connection common to the different telephones, but also controlled the continuity of the talking circuit—that is to say, the main line circuit whereby the energizing of such relay was necessary before any conversation could be carried on over the line. It was found that in some ways this was not always satisfactory.

The object of my invention is, therefore, the provision of an improved party-line or extension telephone system in which the said relay controls only the ground connection that is common to the different telephones on the line, and in which the continuity of the talking circuit is controlled at each telephone by the coöperation of the hook-switch and calling dial thereof, instead of through the medium of the springs or contacts of the said relay, whereby all of the telephones or substations are normally connected with the line, the transmitter circuit being normally open in each case, and the continuity of the line circuit for talking purposes being in no way contingent upon the operation of said relay.

With my improved arrangement the relay is, as before, common to the different subscribers on the line, but unlike the said prior arrangement it does not control the continuity of the talking circuit, and hence any disarrangement or failure of said relay to operate does not put the line out of service.

The nature and advantages of my invention will, however, hereinafter more fully appear.

The accompanying drawing is a diagram representing a main line substation A equipped with two extension telephones A′ and A², connected in multiple with the main line telephone to the subscriber's line, in a telephone system embodying the principles of my invention. The subscriber's line is represented as leading to a first-selector C and through it to the connector D, as will hereinafter more fully appear.

The substation A is a modified form of the well-known type of telephone disclosed in English Patent No. 26,301 of 1906, and is adapted to be used in connection with similar telephones as A′ and A² on the same extended line without interference. This substation A comprises the receiver 2 and a switch-hook 3 for controlling the substation circuits by such means as the cam arms 4, 5 and 6. As the switch-hook is lowered the cam arm 4 momentarily presses the release springs 7, 8 and 9 into engagement, whereby the main line conductors 10 and 11 may be grounded simultaneously. When the switch-hook is down the cam arm 6 separates the springs 12, 13 and 14, as shown at substation A′. The substation ground circuit is normally broken between the coöperating ground springs 15 and 16 by the cam arm 5; but when the said springs are together ground is provided, in a manner to be hereinafter described, to the ground post 17 and to the release spring 7 through the springs 18 and 19 of the ground cut-off relay 20. Said substation also comprises the usual transmitter 21 and induction coil 22 with a primary winding 23 and secondary winding 24. Being an automatic substation it is provided with the usual so-called vertical and rotary impulse springs 25 and 26. The vertical impulse spring is provided with an oblique projection (on its under side) which the vertical impulse teeth are adapted to engage for intermittently driving the spring 25 against the ground post 17. The rotary impulse spring 26, in a similar manner, is provided with the oblique projection 29 which is in turn engaged by

the rotary impulse tooth 30 and thrust against the ground post 17. Said substation is, of course, provided with a dial (not shown) which is secured to the shaft 31, together with a locking dog 32. Furthermore, there is a locking cam 33 that locks the dog 32 while the receiver is on the switch-hook.

For operating the impulse springs 25 and 26 the substation is provided with an impulse wheel 34 which is secured to the shaft 31. This impulse wheel carries on its periphery the so-called vertical impulse teeth 28 and one rotary impulse tooth 30. Said impulse teeth are so arranged that when the dial is drawn down the impulse springs are not carried into contact with the ground post; but as the dial returns, first the vertical teeth 28 engage the vertical impulse spring 25, after which the rotary impulse tooth 30 acts upon the rotary impulse spring 26. In this manner the subscriber's vertical line conductor 10 is given a number of ground impulses, followed by one ground impulse over the rotary line conductor 11. It will be seen that as long as the dial is out of normal position the dog 32 permits the primary circuit springs 12 and 13, and likewise the spring 14, to separate, thus preventing the impulses that are delivered to one line conductor from passing to the other. The means whereby one subscriber may signal another after connecting with the called line comprises a push-button 35 which, when pressed, carries the spring 36 out of engagement with the spring 37 and into engagement with the spring 38, thereby grounding the vertical line conductor 10. At the same time the operation of the push-button separates the springs 39 and 40, thereby opening a circuit through the ground cut-off relay 20 with which the substation is provided. The substation A is also provided with a ringer 41 connected in series with the condenser 42. Said relay 20, together with certain circuits, comprise the important feature of my invention, by means of which a telephone on an extension line is prevented from interfering with another telephone on the same line after the operations of a call have been completed. The extension telephones A′ and A², with which I have elected to disclose my invention, are of the same general type as the instrument A just described.

The first selector C is of the general type of selector switch disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson; involving the switch shaft (not shown) which carries the line wipers 43 and 44 and the private wiper 45. The side switch is controlled by the private magnet 46, and when the side switch is in normal or first position the side switch wipers 47, 48, 49 and 50 engage the contact points 51, 52, 53 and 54. In the second position the side switch wipers engage the contact points 55, 56, 57 and 58, respectively, while in the third position they occupy the contact points 59, 60, 61 and 62, respectively. The first-selector is under the control of the calling subscriber through the medium of the vertical and rotary line relays 63 and 64. While the side switch is in first position the calling subscriber controls the vertical magnet 65 which operates to give the switch shaft a vertical motion. By means of the rotary line relay 64, and while the side switch is in first or second position, the subscriber controls the private magnet 46 and, therefore, the side switch. When the side switch is in second position the rotary magnet 66 is energized, and the switch shaft which carries the wipers 43, 44 and 45 is thereby caused to rotate. The vertical and rotary line relays 63 and 64, acting conjointly, provide means by which the release magnet 67 is operated by the subscriber while the side switch is in first or second position. After the side switch passes to third position, however, (since the selector C is of the trunk-release type) the release magnet 67 is then controlled through the connector D by way of the private wiper 45, and by means of the back-release relay 68.

The connector D is of the same general type of connector switch as that disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson. The connector switch shaft (not shown), like the selector switch shaft, carries the line wipers 69 and 70 and the private wiper 71. The connector switch is also controlled by the calling subscriber through the medium of the vertical and rotary line relays 72 and 73. The vertical line relay 72 directly controls the vertical magnet 74 and also the rotary magnet 75. The purpose of the vertical magnet 74 is to give the shaft and shaft wipers a vertical motion, and that of the rotary magnet 75 is to impart to the shaft wipers a rotary or circular motion. The rotary line relay 73 controls the private magnet 76 which, under certain conditions, controls in turn the vertical and rotary magnets 74 and 75, the release magnet 77, and also the side switch wipers 78, 79, 80 and 81. The side switch, like the side switch of the selector C, has a normal or first position, a second position and a third position. The release magnet 77 is also controlled by the vertical and rotary line relays 72 and 73 conjointly. By the use of the condensers 82 and 83 the circuit through the connector is divided into two sections. The connector is provided with a differentially-wound relay 84 which is composed of the windings 85 and 86.

The function of the relay is to provide the calling subscriber with talking battery current when the back-bridge relay 87 is energized; and also, in conjunction with the vertical line relay 72, to control the ringer relay 88 by means of which the ringer generator H is placed across the terminals of the called line to signal the called subscriber. The back-bridge relay 87, comprising the windings 89 and 90, provides the called subscriber with talking battery current when the primary circuit of the called subscriber is bridged across the line.

The busy-signaling apparatus I may be of any suitable design, as, for example, the one comprising an interrupter 91 in series with the primary winding 92 of the induction coil 93, whereby a busy-signaling current is induced in the secondary winding 94 of the said induction coil. When the side switch is in first position, and when the connector shaft is raised one or more steps, the secondary winding 94 is connected with the side switch wiper 79 through the normal springs 95 and 96.

My improved extension line arrangement will be more clearly understood from a description of its operation, as follows: To signal a subscriber at substation #220 (not shown) the subscriber at station A removes his receiver from the switch-hook, whereupon the cam arm 6 permits the springs 12, 13 and 14 to make contact with each other in the order mentioned, and the cam arm 5 causes the hook spring 98 to engage the spring 99. A circuit is thereby closed through the ground cut-off relay 20 from ground G' through the winding 97 of the relay 20, over the conductor 100, through the contact springs 40 and 39, over the conductor 101, through the hook springs 99 and 98, over the conductor 102, through the lever hook springs 12 and 13, through the two push-button springs 36 and 37, conductor 103, through the transmitter 21, primary winding 23, rotary line conductor 11 to the side switch wiper 48, through said wiper to the contact point 52, thence through the rotary relay 64, through the contact springs 104, 105 and 106 of the bridge-cut-off relay 107 to the battery lead 108, thence through battery B to ground G. Furthermore, at the switch-hook springs 12, 13 and 14 a circuit similar to that just traced is closed through the vertical line relay 63 of the first-selector. This circuit extends from ground G' at the relay 20 to the springs 12 and 13, as explained, then through the spring 14 to the vertical line conductor 10, through the side switch wiper 47, contact point 51, vertical line relay 63, bridge-cut-off relay springs 105 and 106 to the battery lead 108, thence through battery B to ground G. The ground cut-off relay, upon being thus energized, attracts its armature and thereby carries the spring 18 out of engagement with the spring 19. At this stage, then, ground for imparting ground impulses from the telephone to the line conductors is removed not only from the main line instrument A, but also from the extension telephones A' and A². When the dial is operated, however, the cam arm 32 is carried out of engagement with the spring 14, and remains so until the dial returns to its normal position. During this time, then, the springs 12, 13 and 14 separate from one another, thus breaking the circuit previously traced through the ground cut-off relay 20, deënergizing said relay and permitting the springs 18 and 19 to reëngage. Ground is then supplied through said springs to the cooperating ground springs 15 and 16 and through them to the ground post 17, thus providing ground for the operative impulses. When the dial returns to normal position for the first digit, the first-selector switch C is operated to establish connection with the connector switch D. The impulses for the last two digits are directed toward the connector D which operates to place its wipers in connection with the contacts corresponding to the desired line. It will be seen that the circuit through the ground cut-off relay includes the vertical and rotary line relays 63 and 64 of the selector C, but the winding of the relay 20 being of much higher resistance, sufficient current does not flow to operatively energize the line relays 63 and 64. As the dial returns to normal position for the first digit 2 the impulse spring 25 is pressed onto the ground post 17 twice. As a result the vertical line relay 63 of the first-selector C is energized each time by a flow of current from the ground G' through the springs 19 and 18, over the conductor 109, conductor 110 to the coöperating ground springs 15 and 16, through said springs to the ground post 17, thence through impulse spring 25 to the line conductor 10, through the side switch wiper 47, contact point 51, vertical line relay 63, bridge-cut-off relay springs 105 and 106 to the battery lead 108, thence through battery B to ground G.

Each time that the vertical line relay 63 energizes, the line relay spring 111 is pressed against ground spring 112. The vertical magnet 65 is thereby energized, and the wipers 43, 44 and 45 of the selector C are raised to the second bank level, opposite the first contact. The energizing circuit for the said vertical magnet extends from ground G² through the springs 112 and 111, private magnet springs 114 and 115, through the vertical magnet 65 to the battery lead 108, thence through battery B to ground G. Following the vertical impulses the rotary impulse spring 26 is pressed onto the ground post 17, grounding the rotary line conductor

11 and energizing the rotary line relay 64 of the selector C. The energizing current passes from ground G′ through the springs 19 and 18, conductors 109 and 110 to the springs 15 and 16, through said springs to the ground post 17, thence to the rotary impulse spring 26 to the line conductor 11, through the side switch wiper 48, contact point 52, rotary line relay 64, bridge-cut-off springs 104, 105 and 106 to the battery lead 108, thence through battery B to ground G. The rotary line relay, upon energizing, presses the line relay spring 113 onto the ground spring 112, thereby establishing a circuit from ground G^2 through the springs 112 and 113 to the private magnet 46, and through said magnet to the battery lead 108, thence through battery B to ground G. The private magnet, upon energizing and deënergizing, permits the selector side switch to pass from first to second position, permitting the side switch wipers 49 and 50 to engage the contact points 57 and 58, respectively. The contact between the side switch wiper 49 and the contact point 57 completes an energizing circuit through the rotary magnet 66 from ground G^3 to the contact point 57, side switch wiper 49, through the interrupter springs 116, thence through the rotary magnet 66 to the battery lead 108, and through battery B to ground G. The said magnet 66 then operates to rotate the wipers 43, 44 and 45 of the selector C into engagement with the first contact of the second level of the selector C, from which contact it is assumed that the trunk conductors 117, 118 and 119 lead to the connector D. If the first trunk-line is busy, however, and the wipers have to pass over busy trunk-lines, then as soon as the private wiper 45 engages the first private bank contact the private magnet 46 again energizes; retaining the side switch in second position. The energizing circuit for the said private magnet extends from the grounded terminal of battery B through an occupying switch (not shown) to the private wiper 45, then through the back-release relay 68, side switch wiper 50, contact point 58, private magnet 46, thence to the battery lead 108, and through battery B to ground G. The private magnet 46, upon thus becoming energized, locks the side switch wiper 49 in engagement with the contact point 57, whereby the rotary magnet 66 will be energized step by step until the wipers are carried beyond the last busy trunk-line. At the instant that the private wiper leaves the last busy contact point the energizing circuit through the private magnet 46 is destroyed, and as a result the selector side switch passes to third position. If, however, there are no busy trunk-lines the private magnet 46 releases the side switch to third position as soon as the wipers are carried into engagement with the first trunk-line. As soon as the side switch passes to third position, as stated, the substation main line conductors 10 and 11 are extended to the conductors 117 and 118 which in this case, it is assumed, lead to the connector switch D. The extension of the line occurs, of course, as soon as the side switch wipers 47 and 48 engage the contact points 59 and 60, respectively. Not only is the subscriber's line thus extended, but a guarding potential is also established at the private wiper 45, when the side switch wiper 50 passes onto the grounded contact point 62, for protecting the seized trunk-line from interference by other calling subscribers. This guarding potential extends from ground G^4 to the contact point 62, side switch wiper 50, back-release relay 68 to the private shaft wiper 45. It will be seen, of course, that the energizing circuit for the rotary magnet 66, to which reference has already been made, is destroyed when the idle trunk-line is seized—that is, when the side switch wiper 49 leaves the contact point 57. Furthermore, when the first-selector shaft is raised the normal arm 122 permits the spring 123 to pass from the contact point 124 to the contact point 125, whereby a guarding potential is established at the connector bank to prevent a calling subscriber from establishing connection with the normal conductors 126 and 127 while the selector C is busy. This guarding potential extends from ground G^6 to the contact point 125, spring 123, normal conductor 128, thence to the connector bank contact corresponding to the line conductors 10 and 11.

The grounding of the main line conductors 10 and 11 for the last two digits affects the connector by operating the vertical and rotary line relays 72 and 73. When the said vertical line conductor 10 is grounded the vertical line relay 72 is energized by a flow of current from the substation G′ through the vertical impulse spring 25, substation conductor 120 to the main line conductor 10, through the side switch wiper 47, contact point 59, shaft wiper 43, trunk conductor 117, through the vertical line relay 65, winding 85 of the differential relay 84 to the battery lead 108, thence through battery B to ground G. The winding 85 of the relay 84 being included in this circuit, said relay energizes, but this operation at this particular time is without effect. Each time that the vertical line relay operates for the second digit the vertical magnet 74 operatively energizes to move the shaft wipers 69, 70 and 71 in a vertical direction, one step at a time, until the said wipers are carried two steps and thus brought opposite the level in which are located the terminals of the line #220. The circuit through the vertical magnet extends from ground G^5 through the springs 129 and 130, private

magnet springs 134 and 135, side switch wiper 80, contact point 136, vertical magnet 74 to the battery lead 108, thence through battery B to ground G. When the rotary line conductor 11 is grounded, following the grounding of the vertical line conductor, the connector rotary line relay 73 becomes energized over a circuit extending from the substation ground G' to the impulse spring 26, substation conductor 121, thence to the rotary line conductor 11, side switch wiper 48, contact point 60, shaft wiper 44 to the trunk conductor 118, rotary line relay 73, winding 86 of the differential relay 84, through the springs 137 and 138 to the battery lead 108, thence through battery B to ground G. The winding 86 of the differential relay 84 being included in this circuit, as is the winding 85 in the vertical line relay circuit, the said relay 84 energizes, but without effect. The rotary line relay 73, upon energizing, operates to close an energizing circuit through the private magnet 76, which latter in turn operates to release the side switch from first to second position. The energizing circuit through the private magnet 76 extends from ground G^5 through the springs 129 and 131, through the private magnet 76, thence through the springs 137 and 138 to the battery lead 108, and through battery B to ground G. For the last digit the subscriber operates the dial as previously described, grounding the vertical line conductor 10 ten times and the rotary line conductor 11 once. The connector vertical and rotary line relays 72 and 73 are operated over previously traced circuits. However, when the vertical line relay operates, a circuit is closed through the rotary magnet 75 instead of through the vertical magnet 74, since the side switch wiper 80 has passed from first to second position. Each time that the rotary magnet 75 is energized the shaft wipers 69, 70 and 71 are rotated one step at a time until the said wipers are carried into engagement with the normal conductors 143, 144 and 145, the first two of which lead to the main line terminals of the desired substation. The rotary line relay 73, upon energizing, completes an energizing circuit through the private magnet 76 as before. This latter magnet now operates with one of two results, namely the release of the side switch from second to third position, or the so-called busy-release of the connector. It will be assumed that the former result occurs, and that the side switch passes to third position, whereby the side switch wipers 78 and 79 are placed in connection with the shaft wipers 69 and 70, respectively. Furthermore, when the side switch passes to third position a guarding potential is established for protecting the called line. This potential extends from ground G^7 through the side switch wiper 81 to the shaft wiper 71, which latter engages the private normal contact of the called line. Also, when the shaft wiper 71 engages the private contact, and the side switch wiper 81 passes to third position, an energizing circuit is established through a bridge-cut-off relay which operates to cut off battery current from the line relays of the called subscriber.

In order to signal the called subscriber the subscriber at substation A presses the signaling button 35, whereby the vertical line conductor 10 is grounded and the connector vertical line relay 72 and differential relay 84 become energized as before. It will be assumed that the connector side switch has passed from second to third position, and that the side switch wiper 80 now engages the contact point 146, thereby placing the vertical line relay 72 in control of the ringer relay 88 in the same manner that the rotary magnet 75 came under the control of the vertical line relay when the side switch passed from first to second position. Therefore, when the vertical line relay presses the springs 129 and 130 into contact the ringer relay 88 is energized by a flow of current from the ground G^5 through the springs 129 and 130, and 134 and 135 to the side switch wiper 80, contact point 146, thence through the ringer relay 88, springs 142 and 140 (bearing in mind that the differential relay 84 is energized) to the battery lead 108, and through battery B to ground G. The ringer relay, upon energizing, shifts the spring 148 from the spring 147 to the spring 149. The signaling current is, therefore, sent from the generator H to the ringer relay springs 149 and 148, to the side switch wiper 79, shaft wiper 70, normal conductor 144, and thence over a circuit similar to that which begins with the line normal 127 of the first-selector C. The continuation of this circuit is the same as that here represented leading from the normal conductor 127 of the selector C to the extension telephone A' (assuming that all the switch-hooks are down) in order that ground cut-off relay 20 may be deënergized and the circuit thereby completed from the grounded side of the generator round G'. This circuit from the normal conductor 127 passes through the extension of the line conductor 11, conductor 150, condenser 151, ringer 152, conductor 153, through the ground cut-off springs 18 and 19 to ground G'. Signaling current also passes through the ringers 41 and 155 of the substations A and A^2 in multiple with the ringer 152 of the substation A'. As soon as the calling subscriber ceases to press the signaling button 35 the ringer relay returns to its normal position. The subscriber at the called substation recognizing the ring (which may be two short rings) understands that the subscriber at a particular

substation is desired. In response to the signal the called subscriber removes the receiver from the hook. When this is done battery current for talking is supplied to the called subscriber's line from ground G^7 over the rotary side of his line through the winding 90 of the coil 87, through the called subscriber's station, back over the vertical side of the line through the winding 89 of said coil 87, through the springs 141 and 140 to the battery lead 108, thence through battery B to ground G. The relay 87 being thus energized attracts its armature and throws the spring 137 from the spring 138 to the spring 139. This closes a circuit from ground G^7 through the springs 139 and 137, through the winding 86 of the differential relay 84, rotary line relay 73 to the line wiper 44, through the side switch wiper 48, rotary line conductor 11, primary winding 23 of the induction coil 22, through the transmitter 21, push-button springs 37 and 36, hook springs 13 and 14 to the vertical line conductor 10, through the side switch wiper 47, contact point 59, line wiper 43, through the vertical line relay 72, winding 85 of the differential relay 84 to the conductor 108, thence through battery B to ground G. The relay 84 being differentially wound does not now attract its armature. Both the called and calling lines are now supplied with battery current for talking purposes. The ground cut-off relay is now energized over the following circuit: from ground G' through the winding 97 of the relay 20, over the conductor 100, through the springs 40 and 39 to the hook springs 99 and 98, lever hook springs 14, 13 and 12, vertical line conductor 10, side switch wiper 47, contact point 59, line wiper 43, through the vertical line relay 72, winding 85 of the differential relay 84 to the conductor 108, thence through battery B to ground G. The ground cut-off relay 20 may be of 2000 ohms resistance, more or less, so that none of the relays included in a circuit through it at any time are materially affected thereby, except the said relay 20 itself.

The relay 20 being energized over a path just described attracts its armature and thereby separates the springs 18 and 19. By this action operative ground is removed from the substations A, A' and A^2, since as long as the lower hook springs 14, 13 and 12 of the substation A are closed relay 20 will continue to be energized. Should the subscriber at substation A' remove his receiver from the hook and operate his dial he will be unable to thereby interfere with the established connection, since the ground for the rotary and vertical impulses is cut off at said relay 20. In like manner should he hang up his receiver he will not be able to release the established call set up by the subscriber at substation A, since the release spring 156 is without ground. In a like manner the subscriber at substation A^2 can produce no interference by operating his dial or closing his release springs by hanging up his receiver, since ground is restored to the release spring 160 only when the circuit through the relay 20 is broken by the switch-hook separating the lower hook springs 14, 13 and 12.

The release of the central office switching apparatus is brought about when the calling subscriber restores the receiver 2 to the switch-hook 3, thereby pressing the release springs 7, 8 and 9 into engagement for a moment. When the switch-hook 3 is lowered the springs 98 and 99 and the springs 12, 13 and 14 disengage, thereby breaking the energizing circuit through the relay 20. The relay 20 thereby deënergizes and permits the ground springs 18 and 19 to engage, thus providing ground at the substation. The contact of the said release springs connects the vertical and rotary line conductors 10 and 11 simultaneously with ground G' through the release spring 7, 8 and 9. The grounding of the rotary line conductor 11 produces a short-circuit of the rotary line relay 73 in series with the winding 86 of the differential relay 84, if the called subscriber has not already hung up his receiver and allowed the back-bridge relay 87 to deënergize so as to restore battery current to said winding 86. The said circuit extends from ground G^7 to the side switch wiper 81, springs 139 and 137, through the windings 86 and 73, conductor 118 to the rotary line conductor 11, through the substation A to the conductor 109, through the springs 18 and 19 to the ground G'. Therefore, since the winding 85 of the differential relay 84 alone carries current, the said relay becomes energized and attracts its armature which shifts the spring 140 out of engagement with the spring 141 and into engagement with the spring 142. The disengagement of the springs 140 and 141 destroys the energizing circuit through the relay 87, and the spring 137 passes out of engagement with the spring 139 and into engagement with the spring 138. This removes the said short-circuit of the rotary line relay 73 and the winding 86, and establishes instead an energizing circuit which extends from the substation ground G' through the release springs 7 and 8 to the rotary line conductor 11, thence to the rotary line relay 73 and winding 86 of the differential relay 84, through the springs 137 and 138 to the battery lead 108, and through battery B to ground G. The rotary line relay 73 now operates, and the springs 133 and 130 come into contact, thereby establishing an energizing circuit through the release magnet 77 of the connector D in series with the release relay 68 of the selector C. However,

the current now in passing, as before stated, through the winding 86 aids the winding 85 in maintaining the springs 140 and 142 in contact. The energizing circuit through the release magnet extends from ground G^4 to the contact point 62, through the side switch wiper 50, release relay 68, shaft wiper 45, conductor 119, through the springs 130 and 133, release magnet 77, springs 142 and 140 to the battery lead 108, thence through battery B to ground G. When the connector release magnet 77 is thus supplied with current it energizes, and as a result the switch shaft and side switch are restored to normal position, thus breaking the connection between the connector switch shaft wipers 69, 70 and 71 and the normal conductors 143, 144 and 145. The back-release relay 68, being in the same circuit with the release magnet 77, energizes simultaneously with the latter and operates to close a circuit through the selector release magnet 67 by pressing the back-release springs 157 and 158 together. The energizing circuit through the selector release magnet extends from ground G^8 through the springs 158 and 157, through the release magnet 67 to the battery lead 108, thence through battery B to ground G.

If the called line #220 is busy at the time the calling subscriber at substation A attempts to establish connection, the connector D is restored by the last rotary impulse of the rotary line conductor 11, as follows: Said impulse energizes the rotary line relay 73, which relay in turn energizes the private magnet 76, pressing the private springs 159 and 160 into contact after the private wiper 71 has been carried onto the grounded private bank contact. Of course, it is understood that whenever the line #220 is busy the connector private bank contacts connected with the private normal conductor 145 are all connected to ground. Therefore, since the connector side switch is in second position when the private magnet springs 159 and 160 are brought into contact, an energizing circuit is established through the release magnet 77 from the said grounded private bank contact to the private wiper 71, thence to the side switch wiper 81 (which is in second position), to the private magnet springs 159 and 160, to the release magnet 77, through the springs 142 and 140 to the battery lead 108, and through battery B to ground G. When the release magnet is energized the connector switch shaft and side switch are released and connection is not established with the called line. Now when the calling subscriber presses the signaling button the vertical line relay 72 becomes energized and operates to close a circuit through the vertical magnet 74. The vertical magnet operates to carry the switch shaft vertically, whereby the off-normal springs 95 and 96 engage to permit the busy-signaling current to pass to the calling subscriber, in the usual way. Of course, when the subscriber hangs up his receiver after receiving the busy-signal, he grounds the line relays 72 and 73 of the connector D, as previously explained, causing the release of the switching apparatus as formerly.

From the foregoing it will be seen that I provide a common battery party-line or extension telephone system in which a single relay controls a ground connection common to all of the subscribers of the line. It will also be seen, however, that said relay does not control the continuity of the talking circuit, and that the use of the line for talking purposes is in no way dependent upon the action of said relay, as the latter is merely energized to disconnect the ground and thereby render all of the other substations inoperative to disturb any automatic connection already established by the subscriber first in possession of the line. The hook-switch and the calling dial of each substation coöperate to control the talking circuit, and current for talking purposes does not flow through the transmitter of any substation except when the receiver is off the hook and the dial in normal position. When one subscriber is in possession of the line the said relay is immediately energized, so that no other subscriber on the line can get ground for switching purposes—that is to say, no other subscriber on the line can then ground the line and thereby disturb the automatic connection previously set up or obtained by the subscriber first in possession of the line. Even should the said relay fail to operate, the line is still in condition for service, and the subscribers can call and converse in the usual manner, the only difference being that with the relay out of order the party-line is not what would be called non-interfering in character. I find it preferable, however, to have the arrangement of such character that even should the non-interfering feature fail, still the subscribers will be capable of using the line for calling.

What I claim as my invention is:—

1. In an automatic telephone system, a line, a plurality of telephones on said line, a ground connection common to said telephones, means at each telephone for using said ground connection in calling, means responsive to said ground connection to extend connection from the line, and a relay controlling the continuity of said ground connection, both sides of said line being normally closed or continuous between the central station and the said telephones.

2. In an automatic telephone system, a line, a plurality of telephones on said line, a hook-switch and calling dial for each telephone, coöperating to control the continuity of the talking circuit thereat, a ringing key

located at and controlling the talking circuit of each telephone, a ground connection common to the different calling dials and ringing keys on the line, a single relay controlling the said ground connection, means having vertical motion to select groups or divisions of the exchange and rotary motion to connect with a line in the selected group or division, responsive to said calling dials, and means responsive to said ringing keys for supplying ringing current to signal the called subscriber.

3. In an automatic telephone system, a line, a plurality of ringing keys in said line, a ground connection common to the different ringing keys, means responsive to said ground and keys to signal the called subscriber, a ground cut-off relay, and energizing circuits for said relay, each energizing circuit being controlled by one of said keys.

4. In a telephone system, a line, a plurality of telephones on said line, a ground connection common to the different telephones, a ground cut-off relay, a push-button and a switch-hook having springs in the line at each telephone, and energizing circuits for said relay, each of said circuits being controlled by one of said switch-hooks and push-buttons.

5. In a telephone system, a line, a plurality of telephones on said line, a ringing key in the line for each telephone, a ground connection common to the different telephones, automatic switches, means at each telephone for using said ground connection in controlling said automatic switches, means responsive to said ringing keys for supplying ringing current to signal the called subscriber, a ground cut-off relay, circuits controlled at each telephone for energizing said relay, and means for de-energizing said relay by the actuation of any ringing key, whereby ground is restored to the line for enabling the calling subscriber thereon to signal the called subscriber.

6. In a telephone system, a line, means having vertical and rotary motion to extend connection from said line, whereby the said line has a so-called vertical conductor and a so-called rotary conductor, a plurality of telephones on said line, a ground connection common to the different telephones, means at each telephone for using said ground connection in controlling said means by which connection is extended from the line, a ground cut-off relay, means for energizing said relay to cut off the ground when any subscriber on the line takes down his telephone, a ringing key at each telephone, a ringer at each telephone, the ringing circuit of each ringer being from the rotary side of the line to ground and controlled by said relay, and means responsive to said ringing keys for supplying ringing current to signal the called subscriber.

7. In a telephone system, a line, a transmitter in the said line, means for supplying current over the said line to charge the said transmitter for talking purposes, a push-button in the line circuit at the transmitter controlling the flow of current therethrough, a switch-hook, a calling dial associated with and located at the said transmitter, and means whereby circuit is closed through the transmitter by a release of the switch-hook while the said dial is in normal position.

8. In a telephone system, a line, a transmitter in said line, a ground connection, a ground cut-off relay, a calling dial, means by which the calling dial while in normal position closes circuit thereat through both the transmitter and the relay trunk lines, and means for automatically selecting idle trunks responsive to operation of the said dial, as set forth.

9. In a telephone system, a line, a transmitter in said line, a push-button located at the transmitter, an automatic connector provided with a line relay, a ground connection located at the substation of the transmitter, a ground cut-off relay, and means whereby the push-button controls circuit connection thereat through the said transmitter and both of said relays.

10. In a telephone system, a line, a plurality of telephones on said line, a ground connection common to said telephones, an automatic switch, means at each telephone for using said ground connection in controlling said switch, a ground cut-off relay and means for energizing it when any subscriber on the line takes down his telephone, a ringing key at each telephone, means responsive to said ringing keys for supplying ringing current to signal the called subscriber, a hook-switch for each telephone, the equipment of each telephone including three dial-controlled springs, two switch-hook-controlled springs and two ringing-key-controlled springs, and the energizing circuits for said relay being controlled by all of said springs.

11. In a telephone system, a line, a plurality of telephones on said line, a ground connection common to said telephones, a ground cut-off relay similarly controlled at each telephone, an automatic switch, means at each telephone for using said ground connection in controlling said switch, a ringer at each telephone, and a ringer circuit at each telephone controlled by said relay and including said ground connection.

12. In a telephone system, a line, centralized means for supplying current over the line for talking purposes, a plurality of telephones on said line, a ground connection common to said telephones, an automatic

switch, means at each telephone for using said ground connection in controlling said switch, a ground cut-off relay common to the different telephones, circuits and circuit-closing means for energizing said relay when any subscriber on the line takes down his telephone, and a talking circuit free from control by said relay.

13. In a telephone system, a line, a plurality of telephones in said line, a common ground connection for said telephones, means at each telephone for using the ground connection in calling, means responsive to such use of the ground connection for extending connection from the said line in the direction of the called subscriber, a ground cut-off relay common to the different telephones, a ringer at each telephone, and a circuit for each ringer including said ground connection and controlled by said relay.

14. In a telephone system, a line, a plurality of telephones on said line, a ringer for each telephone, a common ground connection, a ground cut-off relay, means whereby the use of any telephone energizes said relay, and circuits for said ringers, each circuit including the common ground connection and controlled by said relay.

15. In a telephone system, a talking circuit, a switch-controlling ground connection, a plurality of rotary calling dials, switches responsive thereto, and a relay between said switches and said calling dials common to all of said dials for directly controlling said ground connection, whereby the switches are responsive to said calling dials.

Signed by me at Los Angeles, Los Angeles county, California, this 6th day of June, 1908.

LEO KELLER.

Witnesses:
E. P. MORPHY,
H. L. BRUBAKER.

Correction in Letters Patent No. 1,113,649.

It is hereby certified that in Letters Patent No. 1,113,649, granted October 13, 1914, upon the application of Leo Keller, of Los Angeles, California, for an improvement in "Non-Interfering Extension or Party-Line Telephone Systems," an error appears in the printed specification requiring correction as follows: Page 4, line 109, after the word "substation" insert the word *ground;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of November, A. D., 1914.

[SEAL.]

R. F. WHITEHEAD,

Acting Commissioner of Patents.