M. SCHWARTZ.

SEMI-AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED DEC. 2, 1911. RENEWED NOV. 9, 1914.

1,146,821.

Patented July 20, 1915.

3 SHEETS—SHEET 1.

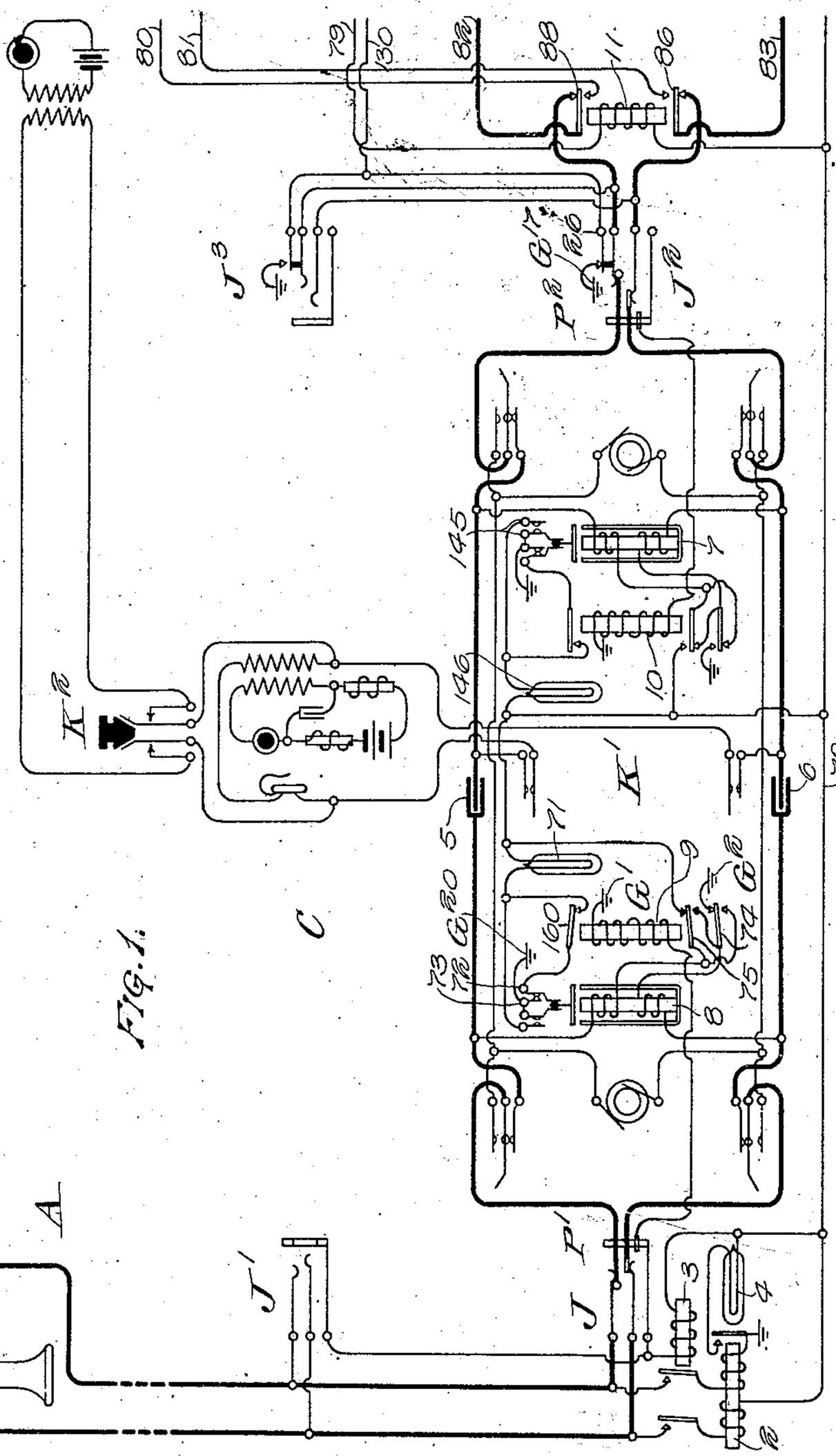

FIG. 1.

WITNESSES

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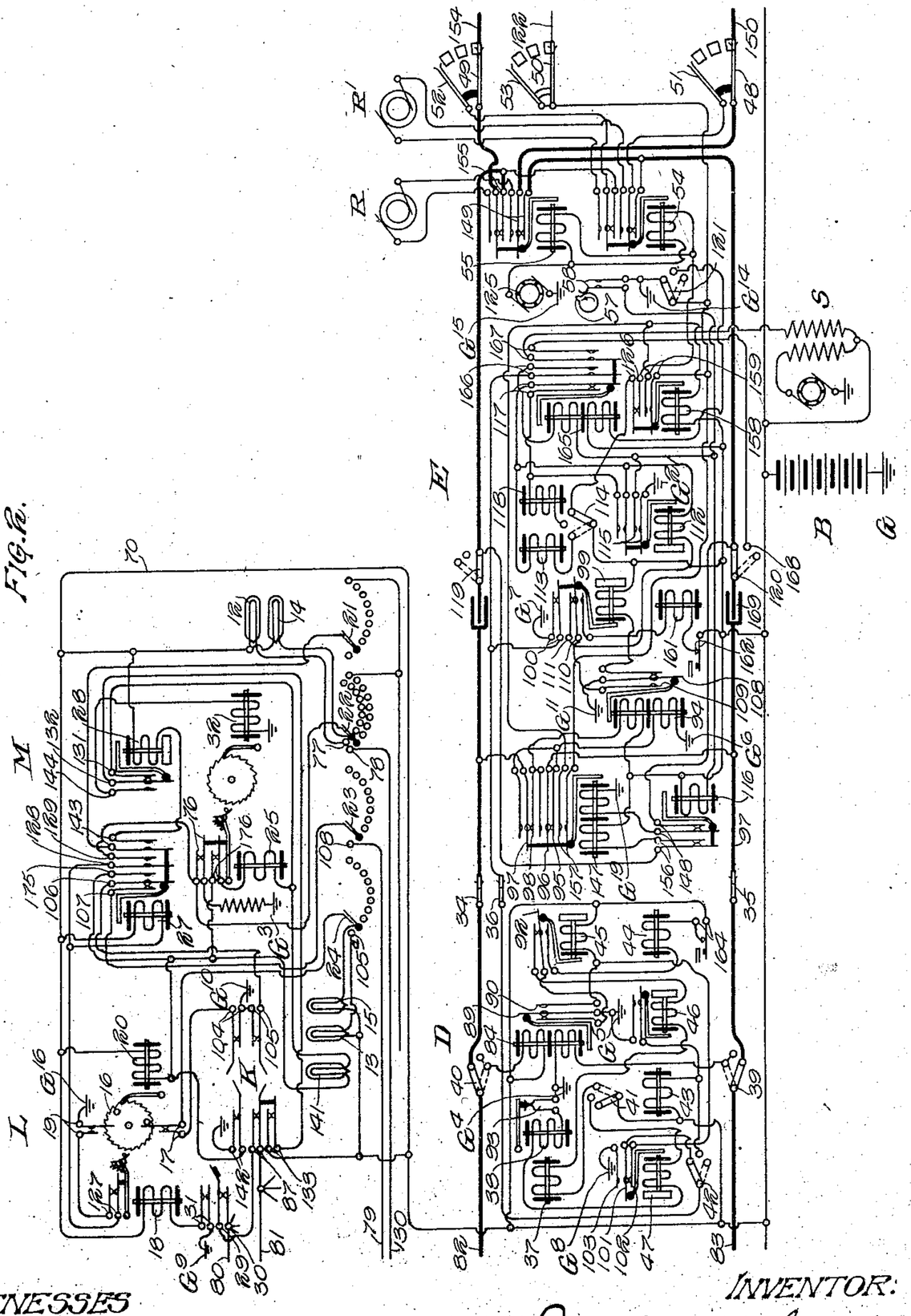
3 SHEETS—SHEET 2.

Fig. 2.



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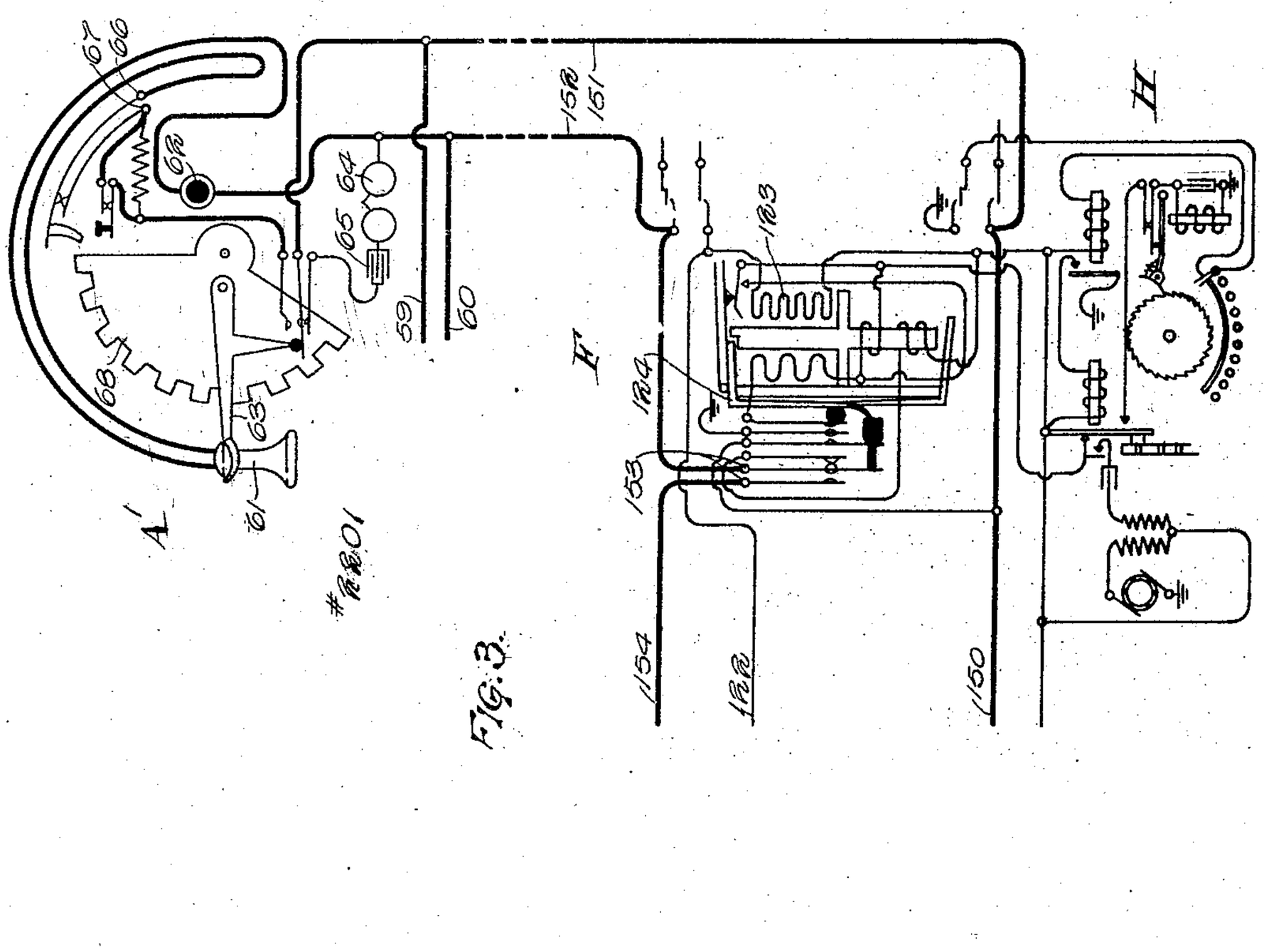

FIG. 3.

WITNESSES.

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UNITED STATES PATENT OFFICE.

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SEMI-AUTOMATIC TELEPHONE SYSTEM.

1,146,821. Specification of Letters Patent. Patented July 20, 1915.

Application filed December 2, 1911, Serial No. 663,567. Renewed November 9, 1914. Serial No. 871,200.

To all whom it may concern:

Be it known that I, MICHAEL SCHWARTZ, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Semi-Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems, and especially to an improved semi-automatic system.

My invention is particularly adapted for use in connection with a semi-automatic system in which manual exchanges are employed having automatic district offices, but it is not limited to use in such a system.

It is customary in systems which employ trunk lines leading from a manual board to automatic switches to have each trunk line accessible to all the operators at the manual board—that is, each trunk line has a multiple jack at each operator's position. On account of the added expense and the complication of the duties of the operators, an automatic calling device is not provided at each operator's position. Instead, the trunk lines are all carried through a special B-operator's position. This position is provided with supervisory lamps for the trunks, one or more calling devices, and a key in each trunk by means of which the calling device may be connected with the trunk. The method of making the call in such a system is as follows: The A-operator, upon receiving an order for connection with the automatic exchange, connects with an order wire and repeats the number of the line wanted to the B-operator. The B-operator then assigns an idle trunk line to the A-operator, all the busy trunks usually being disclosed to the B-operator by means of a lamp which lights whenever the trunk is in use. After assigning the trunk, the B-operator then operates the calling device key of the trunk assigned and operates the calling device for the called number.

In my improved system the general arrangement of the system and the operations of the A-operator are substantially the same as described above. At the B-operator's position, however, the trunk equipment is simplified and the operations required of the B-operator lessened. There are no keys in the trunks at the B-operator's position, the only apparatus appearing before the B-operator being two lamps for each trunk and a calling device. One of these lamps is always displayed on the B-operator's position, this lamp belonging to an idle trunk and designates which trunk the B-operator shall next assign to the A-operator. When the B-operator receives an order she merely looks to see which lamp is displayed, assigns the corresponding trunk and then begins to operate the calling device. This calling device is always automatically connected with the trunk line whose light is displayed, and as soon as the last digit is called the calling device is automatically disconnected from the trunk whose light is displayed and automatically connected with the next idle trunk, and the lamp associated with this last-mentioned trunk is displayed. The second lamp belonging to each trunk is displayed when the A-operator connects with the designated trunk, in order to notify the B-operator when the A-operator has made such a connection. This lamp is not lighted in case the A-operator should plug in upon the wrong trunk.

A further object of my invention is to provide improved means for selectively signaling on a party-line. Heretofore it has been customary to connect each line with a plurality of groups of connectors, or to use a frequency selector of some sort in combination with the selector switches. Other systems have been proposed in which each line is connected with a plurality of contacts in different levels of the same switch, and auxiliary wipers are employed by means of which one generator is connected with the ringing relay springs when the line wipers are raised to one level, and a different generator is connected with said springs when the wipers are raised to a second level. In this manner one kind of ringing current will be sent over the line if it is called over its contacts situated in one level, while a different ringing current will be used if the line is called over its contacts in a second level. In my improved system, however, I provide a connector switch which is similar to the ordinary vertical and rotary type of connector switch, except that it has two ringing relays and two sets of wipers and can be rotated twenty steps instead of the usual ten steps. Two ringing generators of different frequencies are likewise used. The two sets of wipers

are adapted to engage the same bank level, but are angularly displaced so that the second set does not pass onto the first contact until the first set passes off the last contact. When the ringing relays are energized, one generator is connected with one set of wipers, while the other generator is connected with the other set. In this manner the frequency of the ringing current which will be sent out on a called line depends upon which set of wipers is brought onto the contacts of this called line. For instance, if it is desired to call the line connected with the fifth contact in any level, to ring the station upon this line which corresponds to the first of the ringing generators, the shaft is rotated five steps in order to bring the first set of wipers onto the line. If it was desired to signal the station corresponding to the second ringing generator, the shaft would be rotated fifteen steps so as to bring the second set of wipers onto the line. In order to rotate the shaft fifteen steps, the calling device is operated first for 0, for which ten impulses are transmitted, and then 5. This second rotation is made possible by the provision of means for closing the circuit of the private magnet and locking the side switch in second position when the switch shaft is rotated the tenth step, so that the rotary magnet is operative to continue the rotation in accordance with the next series of impulses.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which—

Figures 1, 2 and 3 show a complete connection between a calling and a called substation in a system embodying the principles of my invention. The connection shown is established between a calling manual substation A and a called automatic substation A′. This connection is established through the medium of an operator's cord circuit C, an automatic selector switch D and a connector E. The manual substation A may be of any suitable common battery type. At the central office the manual line is provided with the usual answering jack J, one or more multiple jacks J′, the line relay 2, the cut-off relay 3 and the line lamp 4. The operator's cord C is a cord which is adapted for use either with manual lines or with trunk lines leading to the automatic exchange. This cord comprises the usual plugs P′ and P² connected together through the condensers 5 and 6. The cord is provided with two double-wound polarized relays 7 and 8 and two auxiliary relays 9 and 10. The armatures of the polarized relays return to central position when the relays are deënergized, from which position they may be attracted to either side, depending upon which direction the current flows through the windings. When the relays 9 and 10 are deënergized, the supervisory circuits of the cord are adapted for use in connection with automatic lines. In order to adapt either end of the cord for use with a manual line the corresponding relay 9 or 10 must be energized.

The trunk line leading from the manual exchange to the automatic exchange terminates in the automatic exchange in a selector switch D. At the manual exchange this trunk line is provided with a multiple jack on each operator's position, two of such jacks (J^2 and J^3) being shown in the drawings. Associated with the trunk there is a relay 11 which is for the purpose of connecting an automatic calling device with the trunk. This calling device is situated upon a special or B-operator's position. At this B-operator's position there are also two supervisory lamps 12 and 13 (Fig. 2) for the trunk. The lamps 14 and 15 are similar lamps for a second trunk. For controlling the supervisory lamps and the connection of the calling device with the trunks, there are provided two mechanisms L and M which are common to a plurality of trunk lines. The device L comprises any suitable ratchet device, such as the wheel 16, which is adapted to permit the springs 17 to open when the magnet 18 is energized once, and to close the springs 19 after the magnet 18 has been energized a predetermined number of times. The number of steps of the wheel required to close the springs 19 should be equal to the number of digits in the numbers of the automatic lines. The magnet 20, when energized, withdraws the retaining pawl from the ratchet wheel and allows it to return to normal position. The mechanism M comprises a set of wipers 21, 22, 23 and 24 carried upon a rotary shaft controlled by a motor magnet 25. Each wiper moves over and makes contact with a set of contacts, one contact for each trunk line. The contacts engaged by the wiper 24 are connected with the lamps 13, 15, etc. The contacts engaged by the wiper 23 are connected with the relays 11 of the respective trunk lines. The wiper 22 engages a double set of contacts, one set being connected with the lamps 12, 14, etc., and the other set being connected with the spring 26 of the respective trunk. Only the last contact of the set engaged by the wiper 21 is used, this contact being connected with the springs 26 of the last trunk line of the group. A magnet 32 is provided which, when energized, withdraws the retaining pawl from the shaft which carries the wipers 21, 22, 23 and 24, and allows them to be returned into engagement with first contacts. Associated with the device M there are also two relays 27 and 28. The relay 28 is slow acting—that is, slow to deënergize.

The automatic calling device may be of any suitable type and is represented in Fig. 2 by a pair of impulse springs 29 and 30. Such calling devices are usually controlled by a dial provided with finger holes. The calling device is also provided with a pair of springs 31 which are closed once each time the calling device is operated. If the calling device is controlled by a dial, the springs 31 may be arranged to close as soon as the dial is rotated from normal position and open again when the dial returns to normal position after all the impulses are delivered. The key K is located on the B-operator's position and is common to all the trunk lines. The selector D 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, however, as shown in British patent to T. G. Martin, No. 1419 of 1910, in order to operate in a two-wire system—that is, a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series. Among other details the selector comprises a bank of contacts divided into rows or levels, which contacts are adapted to be engaged by a set of wipers 34, 35 and 36 carried upon a shaft (not shown) which has a vertical movement controlled by the so-called vertical magnet 37 and a rotary movement controlled by the rotary magnet 38. The usual side switch comprising the wipers, 39, 40, 41 and 42 is controlled by the private magnet 43 in a manner well known in the art.

Means for restoring the switch to normal position are provided in the release magnet 44. This magnet restores the switch immediately upon energizing, in a manner similar to that shown in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, for connector switches, rather than by deënergizing as shown in said selector patent. The relays 45, 46 and 47 are slow acting relays—that is, relays which deënergize slowly after their energizing circuits are broken. The proper action of these relays may be obtained by placing a ring of copper around one end of the core. The connector E is of the general type shown in said Patent No. 815,176 referred to above. Like the selector switches, the connector switch comprises a bank of contacts which are adapted to be engaged by a set of wipers carried upon a vertically and rotatably movable shaft. Instead of the usual single set of line and private wipers, the connector E is provided with a double set of wipers 48, 49 and 50, and 51, 52 and 53. The wipers 51, 52 and 53 are arranged in the same plane as the wipers 48, 49 and 50, but are angularly displaced therefrom a proper distance so that as the wipers 51, 52 and 53 pass off the last contact of any certain level, the wipers 48, 49 and 50 will pass onto the first contact. For instance, assuming the usual arrangement of ten contacts in a level, the wipers would be so arranged that upon the eleventh step of the shaft the wipers 51, 52 and 53 would pass off the tenth contact and the wipers 48, 49 and 50 would be rotated onto the first contact of the same level. The wipers 51 and 52 are insulated from the wipers 48 and 49. These two pairs of wipers are normally connected in multiple with each other and with the talking circuit conductors or line through the springs of two ringing relays 54 and 55. However, when the relays 54 and 55 are energized, these wipers are disconnected from each other and from the line, and the wipers 51 and 52 are connected with the terminals of the ringing current generator R′ while, at the same time, the wipers 48 and 49 are connected with the terminals of the ringing current generator R. The two private wipers 50 and 53 are permanently connected together. Upon the switch shaft there is a cam 57 which forces the springs 58 into contact when the shaft is rotated a sufficient distance to bring the most advanced set of wipers into contact with the last contact of a level—that is, assuming ten contacts in a level, the springs 58 would be closed upon the tenth rotary step of the shaft, but would be opened again as soon as the shaft takes the eleventh step. For simplicity, the level of bank contacts shown in Fig. 2 comprises only three contacts. However, in the description which follows the usual arrangement of ten contacts in a level will be assumed.

The automatic substation A′ is assumed to be one station of a two-party line, a second substation in all respects similar to substation A′ being adapted to be connected to the conductors 59 and 60. It is assumed that the line to which the substation A′ belongs is connected to the first contact in the second level of the connector switch. Therefore, if the shaft of the connector is raised two steps and rotated one step, the wipers 51 and 52 will be brought into contact with the terminals of said line; but if the wipers are rotated eleven steps instead of one, the wipers 48 and 49 will be brought into contact with said line. As has been explained, the wipers 48 and 49 are supplied with ringing current from the generator R, while the wipers 51 and 52 are supplied with ringing current from the generator R′. The generator R is assumed to furnish ringing current of the proper character to operate the ringer at the substation A′ only, while the generator R′ furnishes ringing current of the proper character to operate the bells of the other substation on the line. Therefore, it will be seen that the substations may be signaled selectively, depending upon which

pair of wipers is in engagement with the bank contacts of said line. The numbers of the two substations on a line will be the same, except that one substation will have a 0 inserted between the last and the next to the last digits of the number of the other substation on the same line. For instance, the number of substation A′ being assumed to be 2201, the number of the other substation on the same line would be 221. The automatic substation A′ may be of any suitable type and, as herein represented, comprises the usual receiver 61, transmitter 62, switch hook 63, ringer 64, condenser 65 and an automatic calling device comprising a pair of impulse springs 66 and 67 and the toothed impulse wheel 68, which latter is controlled through the medium of a dial (not shown) provided with finger holes. The line of substation A′ is shown connected to an individual line switch F at the central office, which line switch is controlled by a master switch H. The line switch F and master switch H, as shown, are of the general type disclosed in British patent to R. W. James, No. 26,301 of 1906, but of the particular form shown in British Patent No. 1419 of 1910 above referred to.

Having given a general description of the apparatus shown, it will now be explained in detail how the manual substation A may obtain connection with and selectively signal the substation A′ upon an automatic party-line. The subscriber at substation A, by removing his receiver, closes the circuit of the line relay 2, which, upon energizing, closes the circuit of the line lamp 4 in the usual manner to signal the operator. The operator thereupon inserts the plug P′ into the jack J, whereupon the subscriber's line is connected with the cord circuit C and a circuit is closed from ground G′ through the relay 9, sleeve conductors of the plug P′ and jack J and the cut-off relay 3 to the battery lead 70, thence to battery B and to ground G. It will be understood that although only one battery B is shown in the drawings, a plurality of batteries may be employed if found desirable or necessary. The relay 3, upon energizing, disconnects the line relay from the calling line. The relay 9, upon energizing, connects the non-grounded terminal of the battery with the upper winding of the relay 8 and ground G^2 with the lower winding of said relay, and also completes a connection from the lamp 71 to the spring 72 of the relay 8. The insertion of the battery between the two windings of the relay 8 provides the calling substation with talking current which flows over a circuit extending from ground G^2 through the armature 74, lower winding of the relay 8, thence over the heavy conductors to and through the substation A and back over the other side of the line through the upper winding of the relay 8 and the armature 75 to the battery lead 70. This current also energizes the relay 8 and in the proper direction to separate the springs 72 and 73. The operator connects her talking set with the line through the medium of the key K′ and inquires the number of the line desired in the usual manner. Upon learning that a line of the automatic exchange is wanted, the operator restores the key K′ and presses the button K^2, thereby connecting her talking set with an order wire leading to the B-operator. The A-operator then repeats the number of the substation desired to the B-operator and asks to be assigned an idle trunk line over which to complete the connection. The B-operator then assigns an idle trunk line to the A-operator and also operates her calling device to set up the desired automatic connection.

The only operation required of the A-operator after being assigned an idle trunk line is to plug into the trunk line assigned by the B-operator. The B-operator determines which trunk line is to be assigned by means of the lamps 13—15, etc. (Fig. 2.) The trunk line shown in the drawings is the one corresponding to the first set of contacts in the apparatus M (Fig. 2), and it will be assumed that at the time the call was made the wipers were resting upon these contacts. In this position, it will be seen that a circuit is closed from ground G^{10} through the springs 104 and 17, wiper 24, contact 105^a and lamp 13 to the battery lead 70. A circuit is also closed from ground G^{10} through the springs 105, 106, 107, wiper 23, contact 108, conductor 79 and the relay 11 to the battery lead. The relay 11 being energized, the calling device springs 29 and 30 (Fig. 2) will be connected with the trunk conductors 82 and 83 leading to the selector D. Thus it will be seen that normally the calling device is connected with an idle trunk line, and that the corresponding lamp in the B-operator's position is lighted. The B-operator assigns the trunk corresponding to the lamp which is burning, and then simply begins to operate the calling device for the successive digits of the number desired. It will be assumed that the number of the substation A′ is 2201. Since the operator's calling device is normally bridged across the trunk conductors 82 and 83, the selector line relay 84 is energized over a circuit extending from ground G^4 through the lower winding of the relay 84, side switch wiper 39, trunk conductor 83, armature 86, conductor 81, springs 87, impulse springs 29 and 30, conductor 80, armature 88, conductor 82, side switch wiper 40 and the upper winding of the relay 84 to battery. The relay 84, upon energizing, completes a circuit extending from ground G^5 through the springs 89 and 90 and the relay 45 to bat-

tery. Now, when the operator operates her calling device for the first digit 2, the impulse springs 29 and 30 are separated twice momentarily, each time breaking the circuit of the selector line relay 84. The relay 45, being slow acting, does not have time to deenergize during the momentary interruption of its circuit by the relay 84. Therefore, each time the relay 84 deënergizes, a circuit is closed from ground G^5 through the spring 89 and its back contact, spring 92 and its front contact, relay 46, vertical magnet 37 and the side switch wiper 41 to battery. The vertical magnet 37 receives two impulses over this circuit, and operates to raise the switch shaft two steps to carry the wipers opposite the second level of the bank contacts. The relay 46, which is included in circuit in series with the vertical magnet, is energized by the first impulse, but, being a slow acting relay, does not deënergize until after the last impulse is delivered. In its energized position the relay 46 closes a circuit from ground G^5 through the private magnet 43 to battery. The private magnet 43, upon energizing and deënergizing, causes the side switch to pass from first to second position after the vertical magnet has operated the last time. On passing to second position the side switch wiper 41 closes a circuit from ground G^4 through the interrupter springs 93, rotary magnet 38, relay 47 and side switch wiper 41 to battery. Since this circuit includes the interrupter springs 93, the rotary magnet 38 will operate continuously in a manner similar to that of a buzzer to rotate the wipers step by step as long as the side switch remains in second position.

If the first trunk line is idle, the side switch will be tripped from first to second position by the operation of the armature of the private magnet, in the well-known manner, as soon as the wipers have been rotated the first step. If, however, the first trunk line is busy, the private wiper 36 finds a guarding ground potential upon the private bank contact of said trunk line, and a locking circuit is closed from said grounded contact through the wiper 36, side switch wiper 42 and private magnet 43 to battery. The private magnet, being locked up, holds the side switch in second position, and the rotary magnet continues to advance the wipers until an idle trunk is found. When the wiper 36 passes off the last grounded contact, the private magnet 43 deënergizes and allows the side switch to pass to third position. Upon passing from second to third position, the side switch breaks the circuit of the rotary magnet, disconnects the line relay 84 from the line and extends the line connection through the wipers 34 and 35 to the connector E. The connector line relay 94 is thereupon energized over a circuit extending from ground G^6 through the lower winding of said relay, springs 95 and 96, conductor 97, wiper 35, thence to and through the operator's calling device and back over the other side of the line to the springs 97 and 98 and the upper winding of the relay 94 to battery. The relay 94, upon energizing, closes the circuit of the relay 99. The relay 99, upon energizing, extends a guarding potential from ground G^7 through the springs 100 to the selector private bank contacts of the trunk line leading to the connector E. A holding circuit also extends from ground G^7 through the springs 100, selector private wiper 36, side switch wiper 42, springs 101 and 102 and relay 45 of the selector to battery. A short time elapses between the time when the side switch of the selector D passes to third position and the time when the relay 99 of the connector energizes to extend the guarding potential from ground G^7 to the selector private bank contacts. During this time said contacts are provided with a guarding potential extending from ground G^8 through the springs 103 and 101 of the relay 47 of the selector D and side switch wiper 42. The relay 47 is energized in series with the rotary magnet and, being slow acting, remains energized for an instant after the side switch passes to third position, but deënergizes soon enough to permit the locking circuit to be closed through the relay 45 before it has time to deënergize.

As has been explained, the springs 31 associated with the operator's calling device are closed into contact once each time the calling device is operated. These springs, upon closing, complete a circuit from ground G^9 through said springs and the magnet 18 to the battery lead 70. The magnet 18, upon energizing, rotates the ratchet wheel 16 one step, whereby the springs 17 are permitted to separate, thereby breaking the circuit of the lamp 13. The operator now operates her calling device for the second digit 2, thereby causing the line relay of the connector E to deënergize twice. Each time the relay 94 deënergizes, a circuit is closed from ground G^{11} through the springs 108 and 109, 110 and 111 (the relay 99 is slow acting), relay 112, vertical magnet 113 and side switch wiper 114 to the battery lead. The vertical magnet receiving two impulses operates to raise the wipers two steps to a position opposite the second level of bank contacts. The relay 112, which is included in the operating circuit of the vertical magnet, is energized by the first impulse and closes a circuit from ground G^{21} through the springs 115 and the private magnet 116 to battery. The relay 112, being slow acting, does not deënergize to break the circuit of the private magnet until after the last impulse is delivered to the vertical

magnet. The private magnet, upon energizing and deënergizing, causes the side switch to pass from first to second position. The ratchet wheel 16 of the apparatus L is rotated a second step when the second digit is called, but has no particular effect.

When the calling device is operated for the third digit 0, the line relay of the connector is deënergized ten times in the same manner as for the previous digits, but, since the side switch is in second position, the deenergization of the relay 94 at this time completes a circuit from ground G^{11} through the springs 108, 109, 110 and 111, relay 112, springs 117, rotary magnet 118 and side switch wiper 114 to battery. The rotary magnet operates ten times to rotate the shaft and wipers ten steps, thereby carrying the wipers 51, 52 and 53 onto the tenth contact of the second level, and at the same time the cam 57 on the shaft closes the springs 58. The slow acting relay 112 is energized in series with the rotary magnet by the operating impulses and, being slow acting, does not deenergize until after the last impulse is delivered. Since the digit called was 0, and the springs 58 are closed, the private magnet 116 does not deënergize when the relay 112 deënergizes, but remains energized over a circuit extending from ground G^{14} through the springs 58 and said magnet to battery. Since the private magnet does not deënergize after this digit is called, the side switch does not pass to third position, as it would do in case any other digit except 0 had been called, so as not to close the springs 58. The operator now operates the calling device once more for the last digit 1, the line relay deënergizing once, and again closes the circuit of the rotary magnet previously traced. This operation of the rotary magnet advances the wipers one more step, carrying the wipers 51, 52 and 53 off the last contact and advancing the wipers 48, 49 and 50 onto the first contact of the second level. This last step of the switch shaft also permits the springs 58 to open, so that when the relay 112 deënergizes after this digit is called, the private magnet 116 deënergizes also and permits the side switch to pass to third position. The side switch wipers 119 and 120, upon reaching third position, extend the line connection through the connector and its wipers 48 and 49 to the called line. The side switch wiper 121, upon reaching third position, extends a guarding potential from ground G^{14} through said wiper and private wiper 50 to the connector private bank contacts of the called line. An energizing circuit also extends from ground G^{14} through the wipers 121 and 50, conductor 122 and the cut-off winding 123 of the switch F (Fig. 3) to battery. The winding 123, upon energizing, attracts the armature 124, which disconnects the switch F from the called line. The side switch wiper 114 of the connector E, upon reaching third position, completes a circuit from ground G^{15} through the interrupter 125, ringing relays 55 and 54 in multiple, springs 126 and side switch wiper 114 to battery. The relays 54 and 55, upon energizing, disconnect the calling and the called lines and connect the ringing current generators R and R′ with the wipers 48 and 49 and 51 and 52. Since only the wipers 48 and 49 are in connection with the called line, ringing current from the generator R only will be sent over the line. This current is assumed to be of the proper character to operate the bells at the substation A′. If the number 221 had been called, the wipers 51 and 52 would have been connected with the line and ringing current from the generator R′ would have been supplied to the line, which current, it is assumed, does not operate the bells 64 at the substation A′, but would ring the bells of the other substation on the line.

When the ratchet wheel 16 of the device L is rotated the fourth step by the operation of the calling device for the last digit of the called number, the springs 19 are closed into contact. Therefore, when the magnet 18 deenergizes after this digit is called, a circuit is closed from ground G^{16} through the springs 19 and 127 and the relay 27 to the battery lead. The relay 27, upon energizing, completes a circuit from ground G^{10} through springs 105, 106, 175 and 176, magnet 25, springs 131, 132 and 133 to battery. The magnet 25, upon energizing, rotates the wipers 21, 22, 23 and 24 one step onto the contacts corresponding to the next trunk line. The relay 27, upon energizing, also completes the circuit of the restoring magnet 20 of the device L, said circuit extending from ground G^{10} through the springs 105, 106 and 175 and the magnet 20 to battery. The magnet 20, upon energizing, withdraws the retaining pawl from the ratchet wheel 16 and allows it to be restored to normal, thereby disconnecting the ground G^{16} from the relay 27. If the next trunk is idle, the relay 27 deënergizes and breaks the circuits of the magnets 20 and 25. If the next trunk is busy, however, the relay 27 remains energized and causes the magnet 25 to continue to rotate the wipers 21, 22, 23 and 24 step by step onto the contacts of an idle trunk in the following manner: It will be seen that the outer set of contacts which are engaged by the wiper 22 are connected to the springs 26 of the jacks of the trunk lines, so that whenever a plug is in a jack of any trunk line, its contact in this set will be grounded. Therefore, if the second trunk line is busy when the wipers of the device M are rotated the first step, a locking circuit will be closed from the grounded contact of said trunk through the wiper 22 and the springs 129

and 128 and the relay 27 to battery. Thus, the relay 27 will remain locked up and the magnet 25 will continue to advance the wipers 21, 22, 23 and 24 until the contacts of an idle trunk line are reached.

In the drawings it has been assumed that the second trunk line was not busy, and therefore the wipers are shown as having come to rest upon the contacts of said trunk. In this position a circuit is closed from ground G^{10} through the springs 104 and 17, wiper 24 and lamp 15 to battery, thereby lighting the lamp 15 to signify to the operator that this is the next trunk to be assigned. When the relay 27 energizes to cause the wipers 21, 22, 23 and 24 to be rotated, it also breaks the circuit of the relay 11 (Fig. 1). The relay 11, upon deënergizing, disconnects the calling device from the trunk line and completes the connection between the cord circuit and the trunk. When the relay 11 deënergizes to disconnect the calling device from the trunk, it must close a bridge across the trunk at some other point so as to prevent the automatic connection from being released. This bridge comprises the two windings of the relay 7 of the cord circuit C. It will therefore be seen that it is necessary that the A-operator plug into the jack before the B-operator completes the connection. In order to notify the B-operator when the A-operator plugs in, the lamps 12 and 14 are provided. When the plug P^2 is inserted into the jack J^2, a circuit is closed from ground G^{17} through the springs 26, conductor 130, contact point 78, wiper 22, contact point 77 and lamp 12 to battery. Since this circuit includes the wiper 22, it will be seen that neither the lamp 12 nor any other similar lamp will be lighted if the A-operator plugs into the wrong trunk line. The lamp 141 (Fig. 2) is energized in multiple with the magnet 25 for the purpose of signifying to the B-operator when the device M is operating. The key K is for the purpose of providing means whereby the B-operator may release a partially established connection in case she finds she has made a mistake in the operation of the calling device. The separation of the springs 87 by the operation of the key opens the bridge across the trunk line through the calling device, and permits the automatic switches to be released. The closure of the springs 142 closes the circuit of the magnet 20 to allow the device L to be returned to normal position.

If it is desired to put any set of trunks out of service, the key K may be operated to open the springs 104 and 105, thereby allowing the relay 11 to deënergize and also breaking the circuit of the lamp of the trunk line upon which the wipers 21—24 are resting. The wiper 21 is for the purpose of releasing the device M and causing its wipers to be returned to normal position when they reach the limit of their travel. Only the last contact of the row engaged by the wiper 21 is used. This contact is connected with the spring 26 of its corresponding trunk line. Therefore, when the wipers are standing upon the contacts of this trunk line and the plug is inserted into the jack, a circuit is closed from ground through the spring 26 and the trunk line, wiper 21, springs 143 of the relay 27 (when it is energized, as previously explained) and the relay 28 to the battery lead. The relay 28, upon energizing, breaks the circuit of the magnet 25 and closes the circuit from ground through the restoring magnet 32, springs 144 and 132 and springs 133 to battery. The relay 28 is slow acting so as to maintain this circuit closed until the wipers have had time to reach normal position before permitting the magnet 32 to deënergize.

When the relay 7 at the cord C is bridged across the line upon the completion of the connection by the B-operator, in the manner previously explained, this relay is energized by a current which is supplied to the line through the windings of the line relay 94 of the connector E. This current is in the proper direction to cause the relay 7 to close the springs 145, thereby completing a circuit through the lamp 146. When the called subscriber removes his receiver, or as soon thereafter as the ringing relay of the connector deënergizes, the called substation is provided with talking current over a circuit extending from ground G^{19} at the connector E through one winding of the back-bridge relay 147, springs 148, ringing relay springs 149, wiper 48, conductor 150, line conductor 151, thence through the receiver and transmitter of the substation and back over the line conductor 152, springs 153, conductor 154, ringing relay springs 155, springs 156 and the other winding of the relay 147 to battery. The relay 147 is energized by this current and, by shifting the springs 96 and 97 out of engagement with their back contacts into engagement with their front contacts, transposes the connections between the windings of the line relay of the connector and the two sides of the talking circuit. This transposition reverses the direction of the current in the relay 7 of the cord C. This causes the relay 7 to attract its armature in the opposite direction, thereby opening the springs 145 to extinguish the lamp 146 to signify to the operator that the called subscriber has answered. The relay 147 of the connector, upon energizing, also completes a circuit extending from ground G^{14} through the side switch wiper 121, springs 157 and the relay 158 to battery. The relay 158, upon energizing, opens the circuit of the ringing relays 55 and 54 at the springs 126 so that the called subscriber will not be rung again

after he has answered. The relay 158 also forms a locking circuit for itself through the springs 159, so that it will not deënergize when the called subscriber hangs up the receiver and allows the back-bridge relay 147 to deënergize.

When the calling and called subscribers hang up their receivers upon the termination of the conversation, the A-operator is given the usual disconnect signals in the following manner: The hanging up of the receiver at the substation A destroys the circuit of the relay 8 in the cord, which, upon deënergizing, permits the springs 72 and 73 to close, thereby extending a circuit from ground G^{20} through said springs 73 and 72, armature 160 and lamp 71 to battery. The hanging up of the receiver at the called substation breaks the circuit of the connector back-bridge relay 147. The relay 147, upon deënergizing, restores the current in the cord supervisory relay 7 to its original direction, thereby causing the springs 145 to be closed again to light the lamp 146. The A-operator, upon receiving the disconnect signal, simply withdraws the plugs P′ and P^2, whereupon the automatic connection is automatically released as follows: The removal of the plug P^2 breaks the circuit of the connector line relay 94. The relay 94, upon deënergizing, breaks the circuit of the relay 99. The relay 99, upon deënergizing, completes a circuit from ground G^{11} through the springs 108 and 109, spring 110 and its back contact, release magnet 161 and off-normal springs 162 to battery. The magnet 161, upon energizing, immediately restores the connector to normal position, and when the switch shaft reaches its lowest position, the springs 162 are separated to permit the magnet 161 to deënergize. The deënergization of the relay 99 also breaks the holding circuit of the release relay 45 of the selector D. The relay 45, upon deënergizing, closes a circuit from ground G^5 through the spring 89 and its back contact, spring 92 and its back contact, magnet 44 and off normal springs 164 to battery. The magnet 44, upon energizing, releases the selector D, and the switch shaft breaks the circuit of the release magnet 44 at the springs 164 when it reaches its lowest position.

In the above description of the operation of the connector switch it was assumed that the called line was idle. If the called line had been busy, the connector switch would not have completed connection therewith, because, when the wiper 50 engaged the contacts of said busy line and while the side switch was yet in second position, a circuit would have been closed from ground through the guarded private bank contact of the busy line through the private wiper 50, side switch wiper 121 and the lower winding of the relay 165 to battery. The closure of the springs 166 by the energization of the relay 165 completes a circuit from ground G^7 through the springs 100, springs 166, upper winding of the relay 165 and the private magnet 116 to battery. The closure of this circuit maintains the private magnet 116 energized after the relay 112 deënergizes after the last impulse for the last digit is delivered. Since the private magnet does not deenergize, the side switch remains locked in second position and the connection is not completed at the side switch wipers 119 and 120. The relay 165, upon energizing, also completes a connection from one terminal of the busy signaling machine S through the springs 167, contact point 168, side switch wiper 120 and condenser 169 and thence back through the cord circuit to the calling line, thereby giving the calling subscriber a busy signal. The calling subscriber, upon receiving the busy signal, will hang up his receiver and cause the supervisory lamp 71 at the cord to be lighted. Since the back-bridge relay 147 of the connector is deënergized, the relay 7 at the cord will be energized in the proper direction to light the lamp 146. Therefore, the two lamps will be lighted simultaneously and the operator will remove the plugs, whereupon the automatic switches D and E will be released in the same manner as previously described.

In the system shown herein the numbers of some of the automatic substations have only three digits, while other stations have four digits. In the device L the springs 19 must not be closed until the last digit of any number is called, and therefore said springs must not be closed until the wheel 16 has been rotated four steps. If a three-digit number is called, the wheel 16 would, of course, be rotated only three steps. In order to cause these springs to be closed when such a number is called, the operator may be instructed to operate the calling device once more after the last digit is called. This last operation of the calling device will have no effect on the automatic switches other than to momentarily deënergize the line relay of the connector. At the device L, however, this operation of the calling device will cause the wheel 16 to be advanced the fourth step to close the springs 19, which is for the purpose of starting the selection of the idle trunk for the next call.

Although the connector E as shown is adapted to signal only two different substations on the same line, my invention is not necessarily limited to this number. It is evident that by the simple addition of wipers and ringing relays the number of stations which may be signaled selectively may be increased to three, four, or more, as desired. It is likewise to be understood that while I have described this connector in connection with a semi-automatic system, it is

equally as well adapted for use in any system in which automatic switches are employed.

What I claim as my invention is:—

1. In a telephone system, a plurality of trunk lines, an impulse transmitting device, and automatic means for maintaining said impulse transmitting device in connection with an idle trunk.

2. In a telephone system, a plurality of automatic switches, a plurality of trunk lines extending to said switches, an impulse transmitting device for transmitting impulses over said trunks for controlling said switches, and means for maintaining said impulse transmitting device always in connection with an idle trunk.

3. In a telephone system, a manual operator's board, automatic switches, trunk lines extending from said manual board to said switches, an impulse transmitting device for transmitting impulses over said trunks for operating said switches, and automatic means for maintaining said impulse transmitting device always in connection with an idle trunk line.

4. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending from said A-operator's position through said B-operator's position to said automatic switches, an impulse transmitting device at said B-operator's position for transmitting impulses over said trunks for operating said switches, and automatic means for always maintaining said impulse transmitting device in connection with an idle trunk.

5. In a telephone system, a plurality of trunk lines, an impulse transmitting device, automatic means for maintaining said impulse transmitting device in connection with an idle trunk, and a signal to indicate to which of said trunk lines said impulse transmitting device is connected.

6. In a telephone system, a plurality of automatic switches, a plurality of trunk lines extending to said switches, an impulse transmitting device for transmitting impulses over said trunks for controlling said switches, means for maintaining said impulse transmitting device always in connection with an idle trunk, and a signal to indicate to which of said trunk lines said impulse transmitting device is connected.

7. In a telephone system, a manual operator's board, automatic switches, trunk lines extending from said manual board to said switches, an impulse transmitting device for transmitting impulses over said trunks for operating said switches, automatic means for maintaining said impulse transmitting device always in connection with an idle trunk line, and a signal to indicate to which of said trunk lines said impulse transmitting device is connected.

8. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending from said A-operator's position through said B-operator's position to said automatic switches, an impulse transmitting device at said B-operator's position for transmitting impulses over said trunks for operating said switches, automatic means for always maintaining said impulse transmitting device in connection with an idle trunk, and a signal to indicate to which of said trunk lines said impulse transmitting device is connected.

9. In a telephone system, a plurality of trunk lines, a calling device normally connected with one of said trunks, automatic means controllable by said calling device for extending a connection from said trunk line to a called subscriber, and means controlled by said calling device for automatically disconnecting said calling device from the trunk line after the call is completed and for connecting it with an idle trunk.

10. In a telephone system, a plurality of subscribers' lines, a plurality of automatic switches for extending connection to said subscribers' lines, a plurality of trunk lines extending to said switches, an impulse transmitting device normally connected with one of said trunks for controlling said automatic switches, and means for automatically disconnecting said impulse transmitting device from the trunk upon the completion of a call and for then connecting said impulse transmitting device with an idle trunk.

11. In a telephone system, a plurality of subscribers' lines, a plurality of automatic switches for extending connection to said subscribers' lines, a plurality of trunk lines extending to said switches, an impulse transmitting device normally connected with one of said trunks for controlling said automatic switches, and means controlled by said impulse transmitting device for disconnecting said impulse transmitting device from the trunk upon the completion of a call and for then connecting said impulse transmitting device with an idle trunk.

12. In a telephone system, a plurality of subscribers' lines, means for extending a connection between any two of said lines, said means including an A-operator's position, a B-operator's position, automatic switches, trunk lines extending from said A-operator's position through said B-operator's position to said automatic switches, an impulse transmitting device normally connected with one of said trunk lines for controlling said automatic switches, and means for automatically disconnecting said impulse transmitting device from said trunk after the call is completed and for connecting it with an idle trunk.

13. In a telephone system, a plurality of subscribers' lines, means for extending a

connection between any two of said lines, said means including an A-operator's position, a B-operator's position, automatic switches, trunk lines extending from said A-operator's position through said B-operator's position to said automatic switches, an impulse transmitting device normally connected with one of said trunk lines for controlling said automatic switches, and means controlled by said impulse transmitting device for automatically disconnecting said impulse transmitting device from said trunk after the call is completed and for connecting it with an idle trunk.

14. In a telephone system, a manual operator's board, automatic switches, a plurality of trunk lines extending from said board to said switches, an impulse transmitting device normally connected to one of said trunk lines for controlling said switches, and means for automatically disconnecting said impulse transmitting device from the trunk line when the call is completed and for then connecting it with an idle trunk.

15. In a telephone system, a manual operator's board, automatic switches, a plurality of trunk lines extending from said board to said switches, an impulse transmitting device normally connected to one of said trunk lines for controlling said switches, and means controlled by said impulse transmitting device for automatically disconnecting said impulse transmitting device from the trunk line when the call is completed and for then connecting it with an idle trunk.

16. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending to said switches, a calling device normally connected with one of said trunk lines, means at said A-operator's position for connecting with said trunk lines, and a signal at said B-operator's position for indicating when said A-operator connects with the trunk with which said calling device is connected.

17. In a telephone system, a plurality of trunk lines, a calling device normally connected with one of said trunks and adapted to be operated a plurality of times in establishing a connection between a calling and a called subscriber, and means for disconnecting said calling device from said trunk and connecting the same with an idle trunk when said calling device has been operated a predetermined number of times.

18. In a telephone system, an operator's cord circuit, automatic switches, trunk lines extending from said cord to said switches, an impulse transmitting device normally connected with one of said trunks and adapted to be operated a plurality of times in establishing a connection between a calling and a called subscriber, and means for disconnecting said impulse transmitting device from said trunk and connecting the same with an idle trunk when said impulse transmitting device has been operated a predetermined number of times.

19. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending from said A-operator's position through said B-operator's position to said switches, an impulse transmitting device at said B-operator's position normally connected with one of said trunks for controlling said switches, said impulse transmitting device being adapted to be operated a plurality of times in establishing a connection between a calling and a called subscriber, and means for disconnecting said impulse transmitting device from said trunk and connecting the same with an idle trunk when the same has been operated a predetermined number of times.

20. In a telephone system, a plurality of trunk lines, a calling device, a step-by-step switch for connecting said calling device with one of said trunks, and means for operating said switch upon the completion of a call.

21. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending from said A-operator's position to said switches, a calling device at said B-operator's position normally connected to one of said trunks, a step-by-step switch for controlling the connection of said calling device with said trunk, and means for operating said switch upon the completion of each call to connect said calling device with the next idle trunk.

22. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending from said A-operator's position to said switches, a calling device at said B-operator's position normally connected to one of said trunks, a step-by-step switch for controlling the connection of said calling device with said trunk, means for operating said switch upon the completion of each call to connect the calling device with the next idle trunk, and a signal to indicate with which trunk said calling device is connected.

23. In a telephone system, a plurality of trunk lines, a calling device normally connected with one of said trunk lines, a step-by-step switch adapted to control the connection of said calling device with said trunk lines, said switch including a plurality of arms adapted to contact with corresponding bank contacts, and means for returning said arm to the first of said contacts when they come in contact with the last of said contacts.

24. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending from

said A-operator's position through said B-operator's position to said automatic switches, an impulse transmitting device at said B-operator's position for transmitting impulses over said trunks for operating said switches, automatic means for always maintaining said impulse transmitting device in connection with an idle trunk, and means at said B-operator's position for controlling the release of said switches.

25. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending from said A-operator's position through said B-operator's position to said automatic switches, an impulse transmitting device at said B-operator's position for transmitting impulses over said trunks for operating said switches, automatic means for always maintaining said impulse transmitting device in connection with an idle trunk, a signal to indicate to which of said trunk lines said impulse transmitting device is connected, and means at said B-operator's position for controlling the release of said switches.

26. In a telephone system, a plurality of subscribers' lines, means for extending a connection between any two of said lines, said means including an A-operator's position, a B-operator's position, automatic switches, trunk lines extending from said A-operator's position through said B-operator's position to said automatic switches, an impulse transmitting device normally connected with one of said trunk lines for controlling said automatic switches, means for automatically disconnecting said impulse transmitting device from said trunk after the call is completed and for connecting it with an idle trunk, and means at said B-operator's position for controlling the release of said switches.

27. In a telephone system, an A-operator's position and a B-operator's position, automatic switches, trunk lines extending to said switches, a calling device normally connected with one of said trunk lines, means at said A-operator's position for connecting with said trunk lines, a signal at said B-operator's position for indicating when said A-operator connects with the trunk with which said calling device is connected, and means at said B-operator's position for controlling the release of said switches.

28. In a telephone system, a connector switch, a plurality of sets of contact arms for said switch, a plurality of sources of ringing current, means for connecting a different source of ringing current with each set of said arms, a calling device, and automatic means for connecting the calling device with the connector for operating the same.

29. In a telephone system, a subscriber's line, a connector switch for connecting with said line, said switch including a plurality of sets of arms for connecting with the line, a plurality of sources of ringing current, a plurality of relays, means controlled by said relays for connecting a different source of ringing current with each set of said arms, a calling device, and automatic means for connecting the calling device with the connector for operating the same.

30. In a telephone system, a subscriber's line, a connector switch for connecting with said line, said switch including a plurality of banks of contacts, a plurality of arms adapted to engage with each of said banks, said arms being angularly displaced whereby one of said arms leaves the last contact of a bank as the next of said arms engages the first contact, a plurality of sources of ringing current, means for connecting a different source of ringing current with each arm associated with a bank of contacts, a calling device, and automatic means for connecting the calling device with the connector for operating the same.

31. In a telephone system, a subscriber's line, a connector switch for connecting with said line, means associated with the connector for applying ringing current to the said line, said means including a plurality of relays, means controlled by each of said relays for connecting a separate source of ringing current with said line, means for energizing said relays simultaneously and applying ringing current to the line, a calling device, and automatic means for connecting the calling device with the connector for operating the same.

Signed by me at Chicago, Cook county, Illinois, this 24th day of November, 1911.

MICHAEL SCHWARTZ.

Witnesses:

ARTHUR J. RAY,

E. D. FALER.