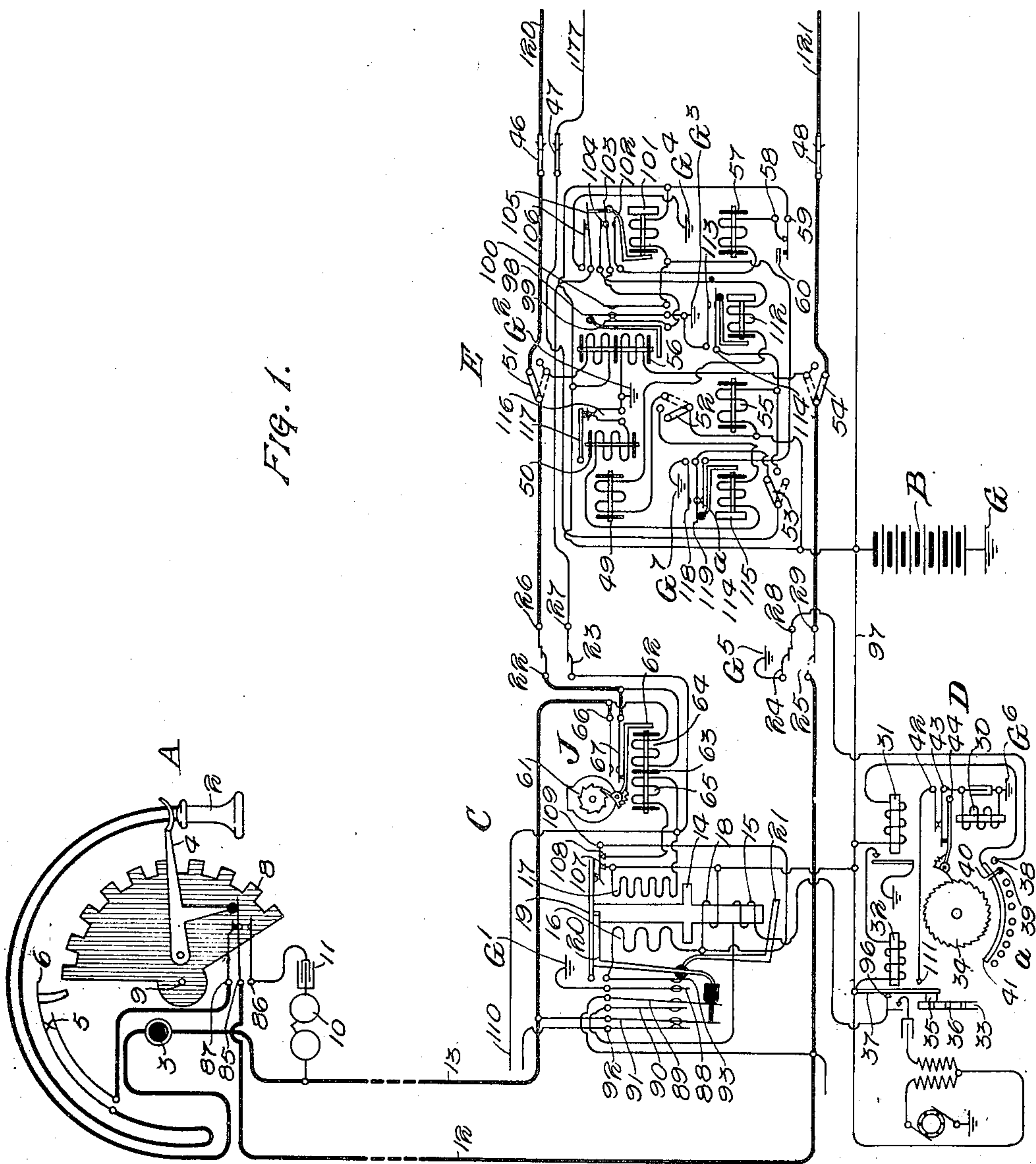


1,236,858.

Patented Aug. 14, 1917.

4 SHEETS—SHEET 1.



WITNESSES
 A. J. Ray.
 A. Andersen.

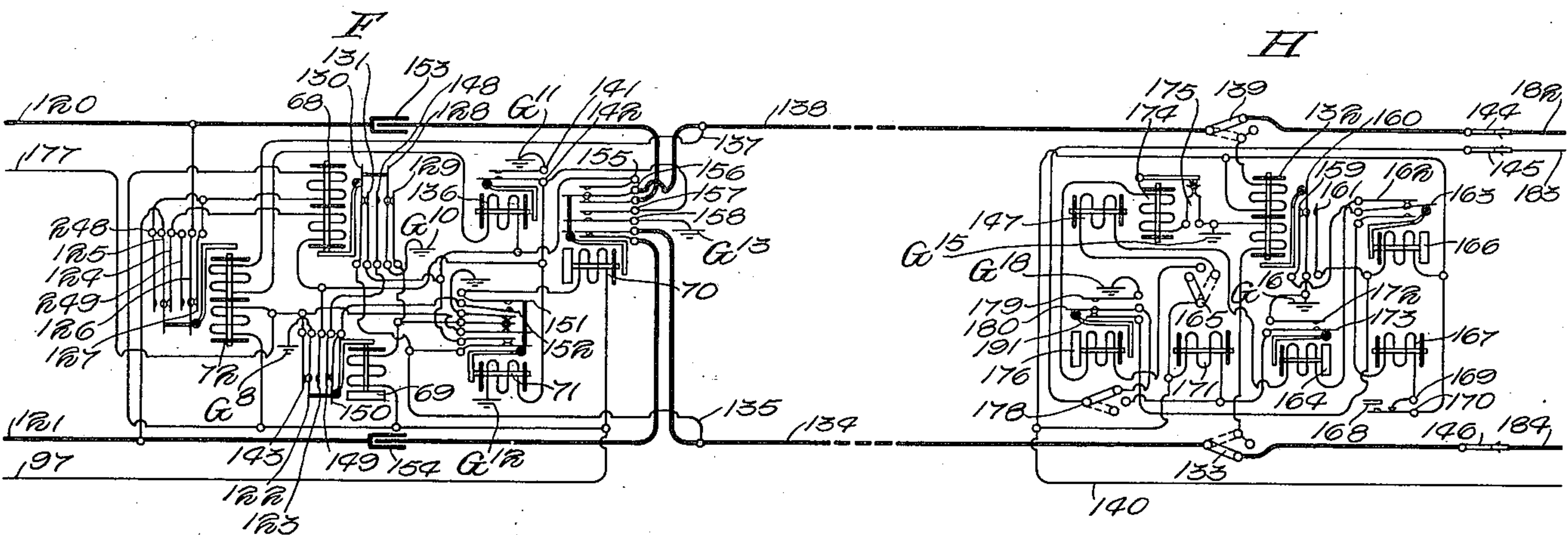
INVENTOR:
 Talbot G. Martin
 By Bulkeley Surand & Dwyer
 ATTORNEYS,

1,236,858.

T. G. MARTIN.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED MAY 6, 1910. RENEWED DEC. 30, 1916.

Patented Aug. 14, 1917.
4 SHEETS—SHEET 2.

Fig. 2.



WITNESSES

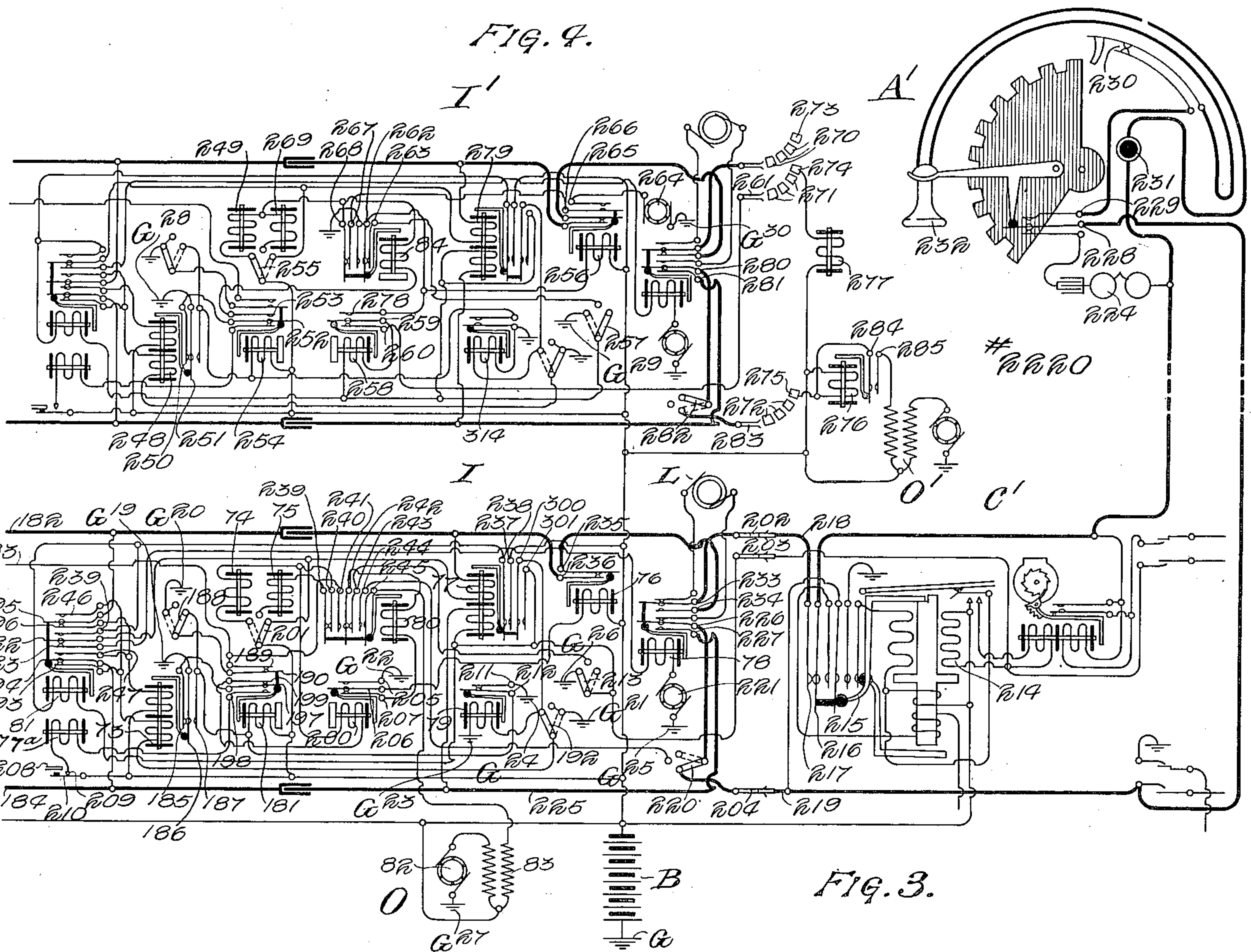
C. J. Ray.
A. Anderson.

INVENTOR:
T. G. Martin
By Buckley, Townsend & Dewey
ATTORNEYS,

1,236,858.

T. G. MARTIN.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED MAY 6, 1910. RENEWED DEC. 30, 1916.

Patented Aug. 14, 1917.
4 SHEETS—SHEET 3.



WITNESSES

A. J. Ray.
A. Anderson.

INVENTOR:
T. G. Martin
By Buckley & Associates
ATTORNEYS,

APPLICATION FILED MAY 6, 1910. RENEWED DEC. 30, 1916.

Patented Aug. 14, 1917.

4 SHEETS—SHEET 4.



INVENTOR:
Talbot S. Martin
By Bulkley Furand & Dury
ATTORNEYS,

UNITED STATES PATENT OFFICE.

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

TELEPHONE-EXCHANGE SYSTEM.

1,236,858.

Specification of Letters Patent.

Patented Aug. 14, 1917.

Application filed May 6, 1910, Serial No. 559,814. Renewed December 30, 1916. Serial No. 139,904.

To all whom it may concern:

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

My invention relates to telephone systems in general, but more particularly to automatic or semi-automatic systems, as it may be used in systems in which the connection is entirely automatic, or in systems in which a calling connection is established by means of both manual and automatic apparatus.

It also relates, more specifically considered, to measured service systems—that is to say, systems in which some provision is made for assessing toll for each successful call, either by the use of a coin or check-controlled mechanism at the substation, or by the use of a registering mechanism located either at the substation or the central station.

My invention contemplates, for example, a system in which the said connectors are provided with means for reversing the talking current in a portion of the talking circuit, when the called subscriber answers, for any suitable or desired purpose.

It also contemplates a system in which automatic connectors and repeaters are employed, the said connectors being provided with means for including resistance in series with a portion of the line or talking circuit when the called line is found, and the said repeaters being provided with similar means for including resistance in series with another portion of the talking circuit when the called line is found, whereby a supervisory signal is displayed at the cord circuit of the originating operator, indicating that the connection has been completed, which signal is then retired when the called subscriber answers.

It further contemplates a system in which the finding of the called line serves, in the manner just explained, to give a signal at the switchboard of the originating operator to show that the desired connection has been completed, and in which the response of the called subscriber not only retires the said signal to show that the call has been answered, but also serves to operate a measured service device, such as a registering

mechanism, which measured service device 55 can be located at any suitable point in the connection, as will hereinafter more fully appear.

My invention also contemplates a rotary connector, *i. e.*, a connector having means for 60 automatically selecting an idle one of a group of lines, having provisions for reversing the current in the calling side of the talking circuit, when the called subscriber answers, for any suitable or desired purpose. 65

It also contemplates certain novel details and combinations and features of improvement tending to increase the general efficiency of a telephone exchange system of this 70 particular character, as will hereinafter more fully appear.

In the accompanying drawings Figure 1 is a diagrammatic view of a portion of the 75 apparatus used in a telephone system embodying the principles of my invention. The apparatus shown in this figure consists of the automatic subscriber's substation A allotted to a line which terminates in the line switch C, there being a master switch D for 80 controlling the plungers of the group of line switches of which the switch C is a member. A meter is also shown at J for registering the calls made by the substation A. At E is shown a first selector, which is one of a 85 group allotted to the trunk lines which are accessible to the group of line switches of which the switch C is a member.

Fig. 2 is a similar view of a repeater F and a second selector switch H, this switch 90 being quite similar to the first selector E.

Fig. 3 is a diagrammatic view of a connector I, line switch C' which is similar in construction to the line switch C, and substation A' which is similar to the substa- 95 tion A.

Figs. 1, 2 and 3 taken together represent a complete circuit connection established between the two subscribers' substations A 100 and A'.

Fig. 4 is a diagrammatic view of a rotary connector I' which can be used in a system embodying the principles of my invention.

Fig. 5 is a similar view of a manual telephone, together with a suitable cord circuit 105 for connecting to the automatic apparatus referred to in the foregoing figures.

The substation A may be of any suitable

or approved type and comprises the usual receiver 2, transmitter 3, switch hook 4, impulse springs 5 and 6, impulse wheel 8, which is secured to a dial (not shown) by means of the shaft 9, ringer 10 and condenser 11.

The line switch C is of the general type disclosed in British Patent No. 26,301 of 1906, and in the *American Telephone Journal* of June 6, 1908. This switch is provided with the usual plunger (not shown) attached to the plunger arm 19 which is adapted to be attracted by the magnet 14. This magnet comprises four windings, a line winding 15, a trip or pull-in winding 16, a cut-off winding 17 and an auxiliary winding 18. The magnetic circuit of the windings 16 and 17 is separate from that of the windings 15 and 18, so that the plunger arm 19 and cut-off armature 20 are affected only by the windings 16 and 17, while the windings 15 and 18 control only the armature 21. The winding 16, when energized, attracts both the plunger arm 19 and cut-off armature 20, while the winding 17 is strong enough to operate only the cut-off armature 20, but will hold the plunger arm in an operated position after the winding 16 deenergizes. The attraction of the plunger arm 19 by the magnet 14 causes the plunger of the switch to be thrust into a group of springs to force the springs 22, 23, 24, 25 into engagement with the springs 26, 27, 28 and 29, respectively, whereby the line conductors are extended over trunk lines to a selector switch such as the selector E, Fig. 1. Although only one set of springs is shown, each switch C is provided with a number of such sets, each set forming the terminal of a trunk line leading to a selector switch. The plungers of the group of line switches of which the switch C is a member are controlled by a common mechanism D usually called a master switch. This master switch controls the plungers in such a manner that the plungers of all idle line switches always stand in readiness to engage the terminal of an idle trunk line leading to a selector switch. The meter shown at J is individual to the substation A and registers only when the subscriber who has been called by the substation A answers. It comprises the ratchet wheel 61 which is actuated by a pawl on the end of the armature 62, which armature is controlled by the relay 63. This relay is composed of the two windings 64 and 65, either one of which alone will not attract the armature 62, but will hold it in its operated position after it is once attracted.

The master switch D comprises a motor magnet 30 which operates the ratchet wheel 34, a bank of contacts *a* and a number of circuit-controlling relays. The master switch bank *a* is provided with a wiper 40 for

keeping some one of the individual segments 38, 39, etc., in electrical connection with the common segment 41. By means of a suitable mechanical connection the rotary motion of the ratchet wheel 34 is transmitted to the plunger shaft, giving said shaft an oscillatory motion to move the idle plungers (which, when normal, are in locking engagement with said shaft) back and forth in front of the bank terminals. To the plunger shaft there is rigidly secured a cam or locking plate 33 having on its surface a number of circular openings 36 which are engaged by the pin 35 on the armature 37.

The openings in the cam 33 are so positioned that the pin 35 can engage an opening only when the plungers that are in engagement with the plunger shaft are directly opposite the terminals of a trunk.

The selector switch E is of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, but, as here shown, is adapted to operate in conjunction with a two-wire system. Among other details the selector comprises a set of wipers 46, 47 and 48 carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 49 and a rotary motion controlled by the rotary magnet 50. The selector also has the usual side switch comprising the wipers 51, 52, 53 and 54. The side switch is controlled by the private magnet 55. The operation of the switch is controlled by the calling subscriber through the medium of the double-wound line relay 56. The release magnet 57 is normally disconnected from battery by the separation of springs 58 and 59, which are held out of engagement by the arm 60 as long as the switch shaft is in its lowest position. The mechanism of the selector E is released immediately by the energization of the release magnet, rather than by its deenergization, as shown in said selector patent.

The repeater shown at F, Fig. 2, is used as a means of repeating impulses which are transmitted from a substation of one exchange to operate switches in another exchange. Among other details it comprises the double-wound line relay 68 and slow relays 69 and 70. The relay 70 operates to cut the condensers out of the circuit while the impulses are being repeated. The repeater also comprises the high resistance relay 71 and the double-wound relay 72.

The selector H, also shown in Fig. 2, is similar to selector E shown in Fig. 1.

The connector I is of the type disclosed in United States Letters Patent #815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but, like the selectors E and H, is adapted to operate in a two-wire sys-

tem. Like the selectors, the connector has a double-wound line relay 73, vertical magnet 74, rotary magnet 75, private magnet 76 and a side switch. In addition, the connector is provided with a back-bridge relay 77, through which the called subscriber is supplied with talking current, a ringer relay 78, by means of which the generator L may be connected across the line, a high resistance relay 79, a busy locking relay 80 and a current-reversing relay 81. The busy signaling machine O consists of an interrupter 82 and induction coil 83.

The rotary connector I' is similar in construction to the connector I, but differs from it slightly as to circuits and manner of operation. When the wipers of connector I are brought into contact with a desired line in response to the operation of the substation calling device, and if said desired line is busy the wipers of the connector I remain upon the contacts of the called line, but connection is not completed with the said line and the calling subscriber is given a busy signal. When the wipers of connector I' are brought into contact with a busy line, said wipers do not remain on this line, but are automatically rotated to the next or an idle set of contacts. In this way the lines which are connected to the banks of connector I' may be divided into a number of groups, all lines of any group being accessible by calling the number of the first line of said group. The set of bank contacts immediately preceding the contacts of any group of lines is connected to relay 276 and resistance coil 277, as shown in Fig. 4.

The substation A' and line switch C' are similar to substation A and line switch C of Fig. 1.

As shown in these drawings, there are a number of batteries B, with the positive terminal preferably grounded at G, for supplying the exchanges with the necessary current for talking and operating purposes; but, of course, in actual practice this number may be changed and the arrangements modified in any suitable manner—that is, one battery may be used for operating one exchange and another battery for operating another exchange. Obviously, any number and any combination of batteries may be used, depending upon the conditions to be met.

Having thus described the general character of the apparatus which is used in the system, I will now describe the process by which the subscriber at substation A establishes connection, signals and converses with the subscriber at substation A', whose number we will assume to be 2220. I will also describe how a call is registered on the meters and the method by which the apparatus is restored to normal condition after the conversation is completed.

I will also describe how the subscriber at substation A² may obtain connection with an automatic substation.

In order to call #2220 the subscriber at substation A must remove his receiver and operate his dial once for each of the four digits 2—2—2—0. As soon as the receiver is removed from the hook the ringer circuit, which is normally bridged across the line, is broken by the separation of the springs 85 and 86, but a circuit is completed through the transmitter and receiver in series by the closing of the springs 85 and 87. The engagement of these springs completes a circuit through the line winding 15 of the line switch C. This circuit extends from ground G' through the springs 88 and 89, line conductor 12, springs 85 and 87, impulse springs 5 and 6, receiver 2, transmitter 3, conductor 13, springs 91 and 90, line winding 15 of the magnet 14, contact 96 and armature 37 to the battery lead 97. The armature 21 of the magnet 14 is attracted upon the energization of the line winding 15, thereby closing the springs 93 and 88 into contact. The closure of these two springs completes the circuit of the pull-in winding 16 in series with the auxiliary winding 18, said circuit extending from ground G' through the springs 88 and 93, pull-in winding 16, auxiliary winding 18 to the battery lead 97. The winding 16, upon energizing, attracts the armature 20, which separates the springs 89 and 91 from the springs 88 and 90, respectively, thus opening the circuit of the line winding 15. The armature 21 cannot fall back, however, until the winding 18 is short-circuited through the springs 107 and 109 by the operation of the plunger arm 19, which may be a little slower in its action than the relay armature 20. The attraction of the plunger arm 19 also serves to thrust the plunger in the bank of springs, closing the springs 22, 23, 24 and 25 into contact with the springs 26, 27, 28 and 29, thus extending the line conductors 12 and 13 to the selector E, as previously explained. As soon as these conductors are extended, however, a circuit is completed through the double-wound line relay 56 of the selector. This circuit extends from ground G² through the lower winding of the relay 56, side switch wiper 54 (in first position), springs 29 and 25, conductor 12, through the substation A in the manner previously described, back over conductor 13, winding 64 of the meter magnet 63, springs 22 and 26, side switch wiper 51 and upper winding of the relay 56 to the battery lead 97, thence through battery B to ground G. The energization of the relay 56 shifts the spring 98 out of engagement with the spring 99 and into engagement with the spring 100. This serves to close the circuit of the release relay 101. This circuit extends from ground

G³ through the springs 98 and 100 and relay 101 to the battery lead 97, thence through battery B to ground G. The energization of the relay 101 shifts the spring 103 out of engagement with the spring 102 and into engagement with the spring 104, and also closes the springs 105 and 106 into contact. The engagement of the springs 105 and 106 closes an energizing circuit through the holding winding 17 of the magnet 14 of the line switch C. This circuit extends from ground G⁴ through the springs 106 and 105, springs 27 and 23, through the holding winding 17 to the battery lead 97, thence through battery B to ground G. The energization of the winding 17 serves to hold the armature 20 and plunger arm 19 in an operated position (as they have not yet been released, due to the slow action of armature 21.)

While the plunger arm 19 is in its operated position it holds springs 107, 108 and 109 in engagement, which short-circuits winding 18, as has been explained, and also provides an energizing circuit for the winding 65 of the meter relay 63. This circuit extends from ground G⁴ through springs 106 and 105 of the relay 101 of selector E, line switch bank springs 27 and 23, winding 65 and springs 108, 109 and 107 to battery lead 97, thence through battery B to ground G. The current in winding 65 is at this time opposed by the current in winding 64 and the meter is not operated.

The energization of relay 101 also serves to place a guarding potential upon the private bank contact of the calling line in the banks of all of the connector switches which have access to the group of lines of which that of substation A is a member. The contacts of the connector banks of the said group are multiplied, so that a guarding potential placed on one contact of one connector bank will also be placed on the same contact of the banks of all the connectors of said group. This guarding potential extends from ground G⁴ to the line switch bank spring 23, as has been previously traced, and thence over conductor 110 to the connector private bank contacts.

Let us return now to the operation of the master switch D when subscriber A removes his receiver. As has been stated, the plunger forces spring 24 into engagement with the spring 28, which completes an energizing circuit through the master switch relay 31. This circuit extends from ground G⁵ through springs 24, 28, segment 38, wiper 40, common segment 41, through relay 31 to battery. The relay 31, upon energizing, completes an energizing circuit through relay 32, which attracts its armature 37, pulling the pin 35 from the opening in the locking plate 33. It also closes an energizing circuit through the motor magnet 30. This circuit extends from ground G⁵ through the motor

magnet 30, interrupter springs 43 and 42, contact point 111 and armature 37 to battery lead 97, thence through battery B to ground G. As the armature 44 is attracted it breaks the circuit of the said magnet 30, causing a buzzer action, thus giving the ratchet wheel a step-by-step rotary motion. The motion of the ratchet wheel is transmitted to the plunger shaft, which operates to move the idle plungers from the position in front of the trunk seized by the line switch C. After the plungers have moved a short distance the wiper 40, which is attached to the plunger shaft, is moved off the segment 38, which corresponds to the trunk seized by the line switch C.

When the wiper 40 leaves the contact 38 the relay 31, and consequently the relay 32, is deenergized, but the armature 37 cannot fall back because the opening in the cam 33 which was formerly engaged by the pin 35 has passed out of register therewith. Thus, the master switch will continue to operate until the next opening in the cam passes under the pin 35, when the said pin will drop into the opening, thus locking the shaft against further movement, and the armature 37 disengages from contact point 111, thus opening the circuit of the magnet 30. If the next trunk after the one seized by the line switch C had been busy the wiper 40 would have found the corresponding contact, contact 39, for instance, guarded, and would have maintained the circuit of the relays 31 and 32 while the next opening in the cam was passing under the pin 35. Thus, the master switch would have continued to advance the plungers past the busy trunk. The armature 37 also operates to disconnect the battery from the line winding 15 of all of the switches C which are controlled by the master switch D, and to connect the busy signaling machine with all of the idle lines through their line windings 15 and springs 90 and 91.

The foregoing operations take place immediately upon the removal of the receiver from the hook at the calling substation and before the impulses are sent in for the first digit of the desired number. When the calling device is operated for the first digit the impulse springs 5 and 6 are separated twice momentarily. The separation of the springs 5 and 6 breaks the energizing circuit of the line relay 56 of the selector switch E. The relay 56, upon deenergizing, permits spring 98 to break contact with spring 100 and come into contact with spring 99, thereby completing an energizing circuit through the vertical magnet 49 in series with the private magnet relay 112. As the relay 101 is slow acting it does not deenergize during the momentary breaking of its circuit at the springs 98 and 100. Therefore, the circuit through the vertical magnet extends

from ground G^3 through the springs 98 and 99, 103 and 104, slow relay 112, vertical magnet 49 and side switch wiper 52 (in first position) to the battery lead 97, thence through battery B to ground G. The slow relay 112 operates to close an energizing circuit through the private magnet 55. This circuit extends from ground G^3 through the springs 113 and 114 and private magnet 55 to the battery lead 97, thence through battery B to ground G. The relay 112 being slow does not deenergize during the momentary breaking of its circuit as the digit 2 is being called. The vertical magnet operates twice to lift the shaft (not shown) two steps, carrying the wipers 46, 47 and 48 opposite the second level of bank contacts, which level contains terminals of trunk lines leading to repeaters F. As soon as the shaft leaves its lowest position the arm 60 is lifted from the spring 59, allowing spring 59 to come into contact with spring 58 to provide the release magnet 57 with a battery connection. After the last impulse is delivered to the vertical magnet 49 the relay 112 has time to deenergize, thereby breaking the circuit of the private magnet 55 which controls the side switch. As this magnet deenergizes it permits the side switch wipers to pass to second position. In second position the side switch disconnects battery from vertical magnets and completes an energizing circuit through the rotary magnet 50 in series with the slow acting guarding relay 115. This circuit extends from ground G^2 through interrupter springs 116, rotary magnet 50, slow relay 115 and side switch wiper 52 to battery lead 97, thence through battery B to ground G. The rotary magnet armature operates once to rotate the wipers 46, 47 and 48 one step onto the bank contacts, to press down the private magnet armature, and to open its own circuit at the interrupter springs 116. The circuit of the rotary magnet being thus opened, the rotary armature falls back. If the first trunk upon the contacts of which the wipers have just been rotated is not busy, the private armature will also fall back, permitting the side switch to pass to third position; but, however, if the first trunk is already in use, the private wiper 47 finds the first contact grounded, and thus completes an energizing circuit through the private magnet, locking the side switch, in second position, thus permitting the rotary magnet to once more energize and deenergize, stepping the shaft wipers onto another contact. The locking circuit of the private magnet 55 extends from the grounded private bank contact over wiper 47, through side switch wiper 53 (in second position) and through magnet 55 to the battery lead 97. The rotary magnet continues to advance the wipers step by step until the private wiper 47 engages the non-grounded

contact of an idle trunk, whereupon the private magnet 55 deenergizes and allows the side switch to pass from second to third position. When the side switch leaves the second position the wiper 52 breaks the operating circuit of the rotary magnet.

The relay 115 energizes in series with the rotary magnet, but, being slow acting, remains energized for a short time after the rotary magnet has deenergized for the last time. Thus the seized trunk is provided with a guarding potential the instant that the side switch passes to third position. This guarding potential extends from ground G^7 over springs 118 and 119, side switch wiper 53 and private wiper 47 to the private bank contacts. When the side switch wipers 51 and 54 pass from second to the third position the line relay 56 of the selector E is disconnected from the line, and the trunk lines 13 and 12 are extended by means of the trunk conductors 120 and 121 to the repeater F of Fig. 2. The circuit is then completed through the double-wound line relay 68 of the repeater F, said circuit extending from ground G^8 through springs 122 and 123, lower winding of relay 68, springs 124 and 125 to trunk line 121, over said trunk line, shaft wiper 48, side switch wiper 54 and then over the same circuit through substation, as was previously traced, back through side switch wiper 51, shaft wiper 46, conductor 120, springs 126 and 127, and through the upper winding of relay 68 to battery lead 97, thence through battery B to ground G. The relay 68 energizes and closes the circuit of relay 69. This circuit extends from ground G^{10} through springs 128 and 129 and relay 69 to battery lead 97. The engagement of springs 130 and 131 by the energization of relay 68 closes an energizing circuit through the double-wound relay 132 of the selector H. This circuit extends from ground G^{15} through lower winding of relay 132, side switch wiper 133, conductor 134, conductor 135 to and through springs 130 and 131, relay 136, upper winding of relay 72, conductor 137, conductor 138, side switch wiper 139, upper winding of relay 132 to battery lead 140, thence through battery to ground. Relay 136 energizes to short-circuit relay 71 by closing springs 141 and 142, thus placing ground G^{11} on the opposite side of relay 71 from ground G^{12} .

When the relay 69 energizes upon the closure of its circuit by the energization of relay 68, a circuit is closed extending from ground G^8 through springs 122 and 143 and through the lower winding of relay 72 to the battery lead 67. Although both windings of relay 72 now carry current, the relay is not operatively energized, because the current flows through its windings in opposite directions at this time. The engagement of springs

122 and 143 of the relay 69 also provides a new guarding potential for the selector private bank contacts of the trunk, and provides a holding circuit for the release relay 101 of the selector E as soon as the guarding relay 115 deenergizes. This circuit extends from ground G^8 through springs 122 and 143 to the selector private bank contacts, thence over private wiper 47, through side switch wiper 53, springs 119 and 114^a of relay 115, and through relay 101 to battery lead 97. The relay 101 is slower to deenergize than the relay 115, so that this latter circuit is closed before relay 101 has time to deenergize. The energization of the two relays 69 and 136 of the repeater F shifts the holding ground of relay 68 from ground G^8 to ground G^{11} .

The apparatus is now in readiness to receive the impulses from the substation for the second digit 2. These impulses are repeated by the repeater F to the selector H, which operates to raise its shaft and wipers 144, 145 and 146 two steps and stop the same opposite the second row of bank contacts. The operation is as follows: The circuit of the line relay 68 of the repeater F is broken twice in response to the operation of the substation dial for the digit 2, thus permitting the said relay 68 to twice momentarily deenergize, causing an energizing circuit to be established through the relay 70, which immediately energizes. This circuit extends from ground G^{10} through springs 128 and 148, springs 149 and 150, 152 and 151 and relay 70 to battery lead 97, and thence through the battery B to ground G. The relay 69 being slow acting does not deenergize during the momentary interruption of its circuit at the springs 128 and 129. The energization of relay 70 serves to disconnect the condensers 153 and 154 from the conductors 138 and 134, and also serves to short-circuit the relay 136 and upper winding of relay 72 by the engagement of springs 155 and 156. The engagement of springs 157 and 158 supplies the ground connection to replace the ground G^{11} which is disconnected by the deenergization of relay 136 when it is short-circuited. Although only the lower winding of relay 72 carries current while the upper winding is short-circuited, this current is not strong enough to attract the armature of the relay.

The separation of the springs 130 and 131 by the deenergization of the repeater line relay 68 breaks the circuit of the selector line relay 132 by opening the bridge across the trunk conductors 138 and 134. Since the digit called is 2, the circuit of relay 132 is thus broken twice momentarily. The relay 70 of the repeater being slow acting remains energized during the entire time impulses are being repeated, and thus maintains the short-circuit of relay 136 and upper winding

of relay 72 to prevent them from being included in the operating circuit of relay 132. Each time the relay 132 is deenergized a circuit is closed extending from ground G^{16} through springs 159 and 160, 163 and 162, slow-acting relay 164, vertical magnet 147 and side switch wiper 165 to the battery lead 140, thence through the battery B to ground G. The vertical magnet 147 is thus energized twice, and operates to raise the switch shaft and wipers carried thereby two steps. As soon as the shaft is lifted from its lowest position the arm 168 is lifted, allowing spring 169 to engage spring 170, which puts battery on one side of release magnet 167. The energization of relay 164 completes an energizing circuit through private magnet 171. This circuit extends from ground G^{16} , springs 172 and 173 and magnet 171 to battery, thence through battery to ground. The relay 164 being a slow relay does not deenergize during the momentary breaking of its circuit between impulses, but does deenergize at the end of the operation of the substation dial for the second digit, thereby permitting the private magnet to also deenergize, which allows the side switch to pass to second position. The side switch, in passing from first to second position, disconnects the battery from the vertical magnet 147 and closes a circuit through the rotary magnet 174. This circuit extends from ground G^{15} through interrupter springs 175, rotary magnet 174, relay 176 and side switch wiper 165 to battery lead 67, thence through battery B to ground. The rotary magnet, upon energizing, operates to rotate the wipers one step, to press down the private magnet armature, and to open its own circuit at the interrupter springs 175. When the rotary magnet circuit is thus opened the rotary armature falls back. If the first trunk upon the contacts of which the wipers have just been rotated is not busy the private armature follows the rotary armature and permits the side switch to pass to third position. If the first trunk is busy, however, the shaft will be rotated to another contact, just as described for the first selector. As the side switch passes to third position the wiper 178 places a guarding potential on the private bank contacts. This extends from ground G^{18} through springs 179 and 180, wiper 178 (in third position) and private wiper 145 to the private bank contact. This potential serves to keep another switch from stopping on a corresponding contact during the time that the side switch wipers are passing to the third position, and also during the time that the relays 73 and 181 of the connector are energizing. As soon as the relay 181 energizes it places a guarding potential back over conductor 183, to replace that just described, as soon as the slow relay 176 deenergizes, and also supplies a ground for

the release relay 166 of the second selector H. Therefore, the holding circuit for relay 166 now extends from ground G^{20} through side switch wiper 188, springs 190 and 189 to conductor 183, shaft wiper 145, side switch wiper 178, springs 180 and 191 to and through relay 166 to battery. As soon as the side switch wipers 133 and 139 pass to third position, the trunk lines 134 and 138 are extended to the trunk lines 184 and 182 which lead to the connector I. The extension of these trunks completes an energizing circuit through the double wound line relay 73 of the connector. This circuit extends from ground G^{21} through the side switch wiper 192, lower winding of relay 73, springs 193 and 194, conductor 184, selector wiper 146, side switch wiper 133, conductors 134 and 135, thence through relays 136 and 72 of the repeater F in the same manner as traced for the relay 132, thence back over trunk conductors 138 and 182, through springs 195 and 196, and upper winding of relay 73 to battery lead 140. The relay 73, upon energizing, operates to close an energizing circuit for relay 181, which in turn energizes and extends a ground connection back over the conductor 183, as already described. The relay 181 also maintains the circuit of release magnet 77^a open by separating springs 197 and 198, and connects the impulse spring 185 with the vertical magnet 74 through the springs 197 and 199 and relay 200.

The foregoing is the operation of the apparatus for the first two digits. The connector I is now in position to respond to the operation of the substation calling device for the third digit 2. The operation of the calling device for this digit twice breaks the circuit of the repeater relay 68. The relay 68 operates to repeat two impulses to the connector line relay 73 in the same manner in which two impulses were repeated to the relay 132 for the second digit. Each time the relay 73 deenergizes a circuit is closed extending from ground G^{19} through springs 186 and 185, 197 and 199, relay 200, vertical magnet 74 and side switch wiper 201 to battery lead 140. The vertical magnet operates, as in the selector switches, to raise the shaft and shaft wipers two steps opposite the second level of bank contacts. The slow relay 200 being in series with the vertical magnet operates to close an energizing circuit through the private magnet 76. This circuit extends from ground G^{22} through springs 205 and 206 and magnet 76 to battery B, thence through battery to ground. The relay 200 being slow acting does not deenergize during the momentary interruption of the current by springs 185 and 186, but does deenergize after the two impulses are sent in, thus permitting the private magnet to deenergize, which allows

the side switch to pass to the second position. The release magnet 77^a is connected to battery in the same manner as in the selectors—that is, after the shaft is raised from its lowest position, the arm 208 permits spring 209 to engage spring 210, thus connecting said magnet to battery.

As the side switch wiper 201 passes to second position, battery is disconnected from the vertical magnet 74 and connected to the rotary magnet 75. The apparatus is now ready for the last digit 0. The relay 73 responds, as before, to the breaking of its circuit by the repeater, in response to the substation calling device, to operate the rotary magnet 75 over practically the same circuit as it did the vertical magnet 74. The rotary magnet operates to rotate the shaft and shaft wipers ten steps onto the terminals of the called line #2220. If the called line is not busy the private magnet deenergizes and permits the side switch wipers to pass to third position. When the wiper 188 passes to third position the holding ground for relay 166 of the selector H is shifted from ground G^{20} to ground G^{19} . The passing of wiper 192 to third position shifts the circuit of relay 73 from ground G^{21} to ground G^{23} , thus placing the high resistance relay 79 in series with the relay 73. The relay 79 energizes to place the springs 211 and 212 in engagement, thus connecting ground G^{24} onto the relay 181 in case the relay 73 should deenergize sufficiently to allow its armature to fall back, thereby disconnecting ground G^{19} from relay 181. The wiper 213, in passing to third position, puts a guarding ground on the private bank contact to prevent the called line from being called by another subscriber, and also grounds the normal conductor which leads to the winding 214 of the line switch C' . This winding attracts the cut-off armature 215, which disconnects ground and the line winding of switch C' from said line and, by engagement of springs 216 and 217, extends the line conductor 218 from wiper 202 to the called substation. The wiper 213 also connects ground to the relays 77 and 81. The wiper 220 (in third position) extends the conductor 225 from the ringer relay springs to the called substation. The wiper 201 (in third position) places battery on the relay 77 and also completes an energizing circuit for the ringer relay 78. This circuit extends from ground G^{25} through interrupter 221, relay 78, springs 223 and 222 and wiper 201 to battery B, thence through battery to ground. The relay 78, upon energizing, disconnects the calling and called lines and connects the ringer generator L with the called line to ring the bells 224. Since the circuit of the ringer relay includes the interrupter 221, the said relay is energized only intermittently so as not to ring the called substation continu-

ously. When the called subscriber removes his receiver, or as soon thereafter as the ringer relay deenergizes, if it happens to be energized at the time, the called substation is provided with talking current over a circuit extending from ground G^{26} through side switch wiper 213, lower winding of relay 77, conductor 225, springs 227 and 226, side switch wiper 220, shaft wiper 204, conductor 219, springs 228 and 229, impulse springs 230, receiver 232, transmitter 231, springs 216 and 217, conductor 218, wiper 202, springs 233 and 234, 235 and 236, upper winding of relay 77 and wiper 201 to battery B, thence through battery to ground. The relay 77, upon energizing, short-circuits the high resistance relay 79 by the closure of springs 300 and 301, and completes an energizing circuit through relay 81 by the engagement of springs 237 and 238. This circuit extends from ground G^{26} through wiper 213, relay 81 and springs 237 and 238 to battery. The energization of relay 81 performs three functions: First, the engagement of the springs 239 and 222 forms a locking circuit for the relay 81, which circuit extends from ground G^{26} through side switch wiper 213, relay 81, springs 239 and 222 and side switch wiper 201 to battery lead 140. Second, the disengagement of springs 222 and 223 breaks the energizing circuit of the ringer relay. Third, the engagement of springs 194 and 195 with springs 247 and 246, respectively, reverses the direction of the current flowing over conductors 182 and 184. As a consequence the direction of the flow of current through the upper winding of relay 72 of the repeater F is reversed, which relay now attracts its armature to bring springs 125 and 126 into engagement with springs 248 and 249, respectively. The engagement of these springs reverses the direction of the flow of current over conductors 120 and 121; but, as in the connector, it does not reverse the direction of the current through the double-wound line relay. This reversal of the current in the conductors 120 and 121 causes the attraction of the meter magnet armature 62, as the current of the two windings of relay 63 are now assisting each other. The attraction of this armature causes the meter to register once by means of the pawl on the armature 62 engaging the ratchet wheel 61 of the meter. It will be remembered that the relay 81 of the connector controls its own circuit; therefore, the meter will only register once no matter how many times the receiver at substation A' is lifted from its hook. The attraction of the armature 62 also closes the springs 66 and 67 into engagement, thereby short-circuiting the winding 64, but as the winding 65 is still energized it serves to hold the armature 62 in an operated position.

After the conversation is completed the

release of the central office apparatus used in the connection is initiated by the restoration of the receiver at the calling substation. When the springs 85 and 87 of substation A are disengaged by placing the receiver on the hook, the energizing circuit of the relay 68 of the repeater F is broken, thus allowing it to deenergize. The separation of springs 128 and 129 breaks the energizing circuit of the relay 69. This relay deenergizes to disconnect the holding ground from the release relay 101 of the selector E. The deenergization of relay 101 closes an energizing circuit through the release magnet 57 over the following circuit: ground G^3 , springs 98 and 99, 103 and 102, magnet 57 and springs 58 and 59 to battery. This circuit is broken again by the springs 58 and 59 when the shaft reaches its lowest position. The deenergization of relay 101 also breaks the holding circuit of the winding 17 of line switch C, which deenergizes and allows the plunger arm to be restored to normal position, thus breaking the energizing circuit of the winding 65 of the meter magnet, whose armature is also restored to normal position. The release of the second selector and connector is quite similar to that of the first selector. The deenergizing of the line relay 68 of the repeater F opens the circuit of the line relay 73 of the connector, which deenergizes to break the holding circuit of the release relay 181 of the connector and of relay 166 of selector H. The relay 166, upon deenergizing, closes the circuit of the release magnet 167, as in the first selector E. The engagement of springs 197 and 198 of relay 181 closes a circuit through the release magnet 77^a of the connector over the following circuit: ground G^{19} , springs 186 and 185, 197 and 198, magnet 77^a, springs 209 and 210 to battery B, thence through battery to ground. The connector, upon restoring to normal position, breaks the circuit of the winding 214 of line switch C' at the private wiper 203; thus all the switches are now in readiness for another call.

In case a line is already busy when called, the calling subscriber is given the busy signal in the following manner: As has been explained, whenever a line is busy there is a guarding ground potential upon its connector private bank contacts. Thus, when the relay 200 of the connector I deenergizes, with the private wiper 203 resting upon the private bank contact of a busy line, a circuit is closed extending from ground at said private bank contact, thence over wiper 203, side switch wiper 213 (which is then in second position), springs 243 and 242, relay 80, springs 207 and 206 and private magnet 76 to battery lead 140. The spring 206 engages spring 207 before it breaks contact with spring 205, and thus the energizing circuit of the private magnet is not broken when

the relay 200 deenergizes. The private magnet therefore remains energized, locking the side switch in second position, and at the same time relay 80 is energized in series therewith. When relay 80 energizes, the spring 242 engages spring 241 before breaking contact with spring 243, thereby shifting the holding ground for relay 80 and private magnet 76 from the private wiper 203 to ground G^{20} . This circuit extends from ground G^{20} through side switch wiper 188, springs 190 and 189, springs 241 and 242, relay 80, springs 207 and 206 and magnet 76 to battery. The disengagement of springs 239 and 240 of relay 80 breaks the circuit of the rotary magnet 75. The calling subscriber now receives the busy signal over the circuit extending from battery through secondary winding of induction coil 83, springs 245 and 244, side switch wiper 220, springs 226 and 227, conductor 184, through substation A, back over conductor 182, springs 195 and 196, upper winding of relay 73, and battery lead 97 to the starting point. The primary busy circuit extends from ground G^{27} through interrupter 82, primary of induction coil 83 to battery, thence through battery to ground. While the calling subscriber is receiving the busy signal, the connection with the called line is open on one side at the side switch wiper 220, and on the other side at the private magnet springs 235 and 236. The switches are released from this position by the hanging up of the receiver at the calling substation in practically the same manner as when the called line was idle.

The rotary connector I' shown in Fig. 4 is, as before mentioned, quite similar to the connector switch shown in Fig. 3. The rotary connector switch is controlled by the calling subscriber over trunk lines leading from the banks of the selector H. The repeater F works in conjunction with this rotary connector the same as with connector I. This type of connector is used where a business house or private branch exchange, for instance, desires to have a plurality of trunk lines extending to the central office, but wish to be given only one number. This connector is so arranged that if the first of these trunk lines is in use, it will automatically extend the calling subscriber's line into connection with the second line; if the second line is also busy the connection will be extended to the third line, and so on. The calling subscriber would, of course, have no control over the apparatus as to with which one of the lines he may make connection. This, however, does not concern him, since any trunk line to the said office or private branch exchange will serve his purpose. The arrangement of the connector banks will be as follows: Suppose, for instance that the office or business house to which the number 2121 has been

assigned wishes three telephones, it will be given three lines, one terminating in the first contact of the second level of the connector banks, the second in the second contact of the second level, etc. Now suppose, for instance, that the substation A, instead of calling #2220, as was heretofore described, calls the number 2121. The action of the line switch, first selector and repeater is the same as before. The shaft of the second selector, however, instead of being raised two steps as before, will, in response to the calling device for the second digit 1, be raised only one step and, as before, automatically rotated one step onto the terminals of a trunk line leading to the said rotary connector. The operation of the connector in response to the calling device for the last two digits is as follows: The circuit of the double-wound relay 248 is broken twice in response to the calling device, or, more strictly speaking, since the calling device controls the repeater, in response to the repeater. The deenergizing of relay 248 closes an energizing circuit through the vertical magnet 249 in series with the slow relay 84. The circuit extends from ground G^{28} through springs 251 and 250, 252 and 253 (as the relay 254 is energized), slow relay 84, vertical magnet 249 and side switch wiper 255 to battery B, thence through battery to ground. The vertical magnet energizes to raise the shaft and shaft wipers two steps opposite the second level of bank contacts. The energizing of the private magnet relay 84 closes an energizing circuit through the private magnet 256, which relay, upon deenergizing, allows the side switch to pass to second position. The passing of the side switch wiper 255 to the second position switches battery from the vertical magnet 249 to rotary magnet 269. The calling device is now operated for the last digit (1). The rotary magnet responds by rotating the shaft one step onto the first bank contact. As before stated, this is the first of the lines leading to the called subscriber. If this contact is not busy the side switch passes to third position in the usual manner, completing the line connection to the called substation and placing a guarding ground on the private bank contact over a circuit extending from ground G^{29} through side switch wiper 257, relay 258, springs 259 and 260 to private wiper 261. This prevents another connector from stopping on this contact. In case the first contact is busy, however, the wiper 261 will find the first contact grounded. Then, as soon as the relay 84 deenergizes, a circuit is completed extending from the ground at the private wiper 261 through springs 260 and 259, relay 258, side switch wiper 257 (in second position), springs 263 and 262, private magnet 256 to battery, thence through battery to ground. The relay 258 does not energize over this

circuit. The private magnet 256, however, remains energized after relay 84 deenergizes, completing a circuit extending from ground G^{30} through interrupter 264, springs 265 and 266, 267 and 268, rotary magnet 269 and side switch wiper 255 (in second position) to battery B, thence through battery to ground. This interrupted current through the rotary magnet operates to energize the rotary magnet, which in turn rotates the shaft one step onto the second bank contact. If this contact is idle the private magnet deenergizes and the side switch passes to third position in the usual manner. If the second contact is also busy the shaft will continue to rotate until the private wiper finds an idle contact. Should all of the trunk lines be busy the subscriber is given the busy signal as follows: The shaft wipers are rotated over all of the busy trunk lines, such as 270, 271 and 272, but stop on the next adjacent contacts 273, 274 and 275. The private contact 274 is connected through a resistance to battery. The contact 273 may be dead, while the contact 275 is connected through a relay 276 to battery. As the connector wipers pass onto the contact 274 the private wiper is shifted from ground to battery through the resistance 277. This allows the private magnet to deenergize, which in turn allows the side switch to pass to the third position. A circuit is then completed extending from ground G^{29} through the side switch wiper 257, relay 258, springs 259 and 260, private wiper 261 and resistance 277 to battery B. The relay 258, upon energizing, causes the spring 259 to engage the spring 278 a short time before breaking from the spring 260. This is to allow a new circuit to be established through the relay 258 before the old circuit is broken. This new circuit extends from ground G^{29} through the relay 258, springs 259 and 278, private magnet 256 to battery. Although the current flowing through the relay 258 in series with the private magnet 256 is not sufficient to attract the armature of the relay from its normal position, it is sufficient to hold said armature in its operated position after it is once operated. The disengagement of the springs 259 and 260 disconnects ground from the private wiper, thus allowing another subscriber to also stop on the contact 274 that he may receive the busy signal. The relay 276 energizes over a circuit extending from ground G^{29} through the lower winding of the relay 279, ringer springs 281 and 280, side switch wiper 282, shaft wiper 283, contact 275 and relay 276 to battery, thence through battery to ground. This relay, upon energizing, gives the subscriber the busy signal over the following circuit: battery, secondary of induction coil of the busy machine O' , springs 285 and 284, contact 275 and wiper 283, then over the same circuit as described in connec-

tion with the connector I. The other features of this connector are essentially the same as in the connector I. Of course, it is evident that another group of lines could be connected to the contact beginning with the set of contacts following the contacts 273, 274 and 275. To obtain connection with one of these lines it would be necessary to call #2125, assuming contacts 273, 274 and 275 are the fourth set, as shown in the drawings.

As shown in Fig. 5, the cord circuit R consists essentially of the answering plug p and calling plug p' , supervisory relays 287 and 288, lamps 289 and 290, repeating coil N, key K, operator's set M and calling device 291. A magneto telephone is also shown at substation A^2 in Fig. 5.

It will now be explained how supervision is brought about in the cord circuit in case the subscriber at the manual substation A^2 calls the subscriber A' . The subscriber A^2 removes his receiver and operates the hand generator 292 in the usual manner, which places a current on the conductors 293 and 294 to operate the drop 295. The operator inserts the plug p into jack j in response to the signal, and throws the key K, thereby cutting her set into the circuit. Upon learning the number desired by the calling subscriber, the operator inserts the plug p' into the jack j' . The trunk conductors 298 and 299 of the jack j' lead to a line switch C^2 in the same manner that the line conductors 12 and 13 lead to the line switch C. The line switch C^2 is in all respects similar to the line switch C, except that the normal conductors may be omitted. The line switch C^2 has access to first selector switches in the same manner as the line switch C, through the medium of which the operator is enabled to set up any desired automatic connection. By throwing the key K' the operator disconnects the talking set M and windings 296 and 297 of the repeating coil N from across the trunk conductors 298 and 299, and connects the calling device 291 across the trunk instead. The operator now sets up the call through the line switch C^2 , selector E, repeater F, selector H and connector I in exactly the same manner, and the operation of said switches is the same, as when the subscriber at substation A called substation A' . It will be remembered that when the connector side switch 192 passed from second to third position, the high resistance relay 79 was included in series with the double-wound line relay 73, and consequently in series with the relays 136 and 72 of the repeater F. The relay 136 does not receive enough current when connected in series with relay 79 to be operatively energized; consequently, when the relay 70 of the repeater deenergizes after the last digit is called, the high resistance relay

71 is included in circuit with the double-wound line relay 68. When the operator restores the key K after completing the call, the relay 288 is bridged across the line and thus is connected in a series circuit with relays 71 and 68 at the repeater F. The relay 288 does not receive enough current when connected in series with relay 71 to be operatively energized, and does not break the circuit of the lamp 290 which was closed as soon as the plug p' was inserted into jack j' . This circuit extends from ground G^{30} through sleeve of jack j' and plug p' , springs 305 and 304, contact 306, armature 308 and lamp 290 to battery B, thence through the battery to ground. The energization of the relay 71 at the repeater F provides a new holding ground for the relay 69, maintains the bridge across the trunk conductors 134 and 138 closed and prevents the closure of the circuit of relay 70 in case the line relay 68 allows its armature to fall back when relay 71 enters its circuit. When the called subscriber removes his receiver the back-bridge relay 77 energizes and short-circuits the relay 79 in the same manner as when substation A' was called by subscriber at substation a. When the relay 79 is short-circuited it reduces the resistance of the circuit of relay 136 of the repeater F sufficiently to allow said relay to operatively energize. The energization of relay 136 serves to short-circuit the relay 71, which reduces the resistance of the circuit of the repeater line relay 68 and of the supervisory relay 288 of the cord R sufficiently to cause these relays to be operatively energized. The energization of relay 288 breaks the energizing circuit of the lamp 290, which signifies to the operator that the called subscriber has answered. When the called subscriber hangs up his receiver upon the termination of the conversation, the connector back-bridge relay 77 deenergizes and removes the short-circuit from relay 79. The relay 79 thus again enters the circuit of the relay 136, which then allows its armature to fall back, removing the short-circuit from the relay 71. This reduces the flow of current through the supervisory relay 288 sufficiently to cause its armature to fall back and again close the circuit of lamp 290. The line switch C^2 is provided with a meter like the meter J (Fig. 1). This meter is operated by the reversal of the current when the called subscriber removes his receiver in the same manner as explained for the meter J when a call was made from substation A.

Supervision in the other side of the cord is taken care of by the relay 287 in the usual manner. This relay is energized through its right-hand winding by current from the substation generator 292. When the relay 287 is thus energized it forms a locking circuit for itself extending from ground G^{31}

through sleeve of jack j and plug p , springs 310 and 309, contact 311 and winding 312 to battery B. The lamp 289 is then lighted over a circuit extending from ground G^{31} through sleeve of jack j and plug p , contact 313 and lamp 289 to battery B. Upon the removal of the plugs from the jacks both lamps are extinguished and the selector and connector switches and the repeater are restored to normal position, just as when the receiver at the calling substation A was restored to the switch hook in the first connection described.

It will be noted that the rotary connector I' is supplied with a high resistance relay 314 which is similar to relay 79 of connector I, and supervision is obtained through connector I' in the same manner as through connector I.

It will be understood, of course, that the supervisory relays 79 and 71 of the connector I and repeater F operate in the same manner when an automatic subscriber calls as when a manual operator sets up the call. The operation of these relays is without any particular function, however, when the call comes from an automatic substation, as the insertion of a resistance in the line before a subscriber answers has no effect on the meters.

From the foregoing it will be seen that I provide a system in which the subscribers are given measured service, and in which toll is assessed by a mechanism which is responsive to the reversal of current in the talking circuit. The reversal of the current may be in the calling subscriber's line, or in a part of the talking circuit between the calling and called lines, depending upon the conditions and requirements of any particular case. For this purpose, as explained, a connector is provided having means for reversing the current in the talking circuit—that is to say, in that portion of the talking circuit which is between the calling subscriber and the connector. The said connector may be one for ordinary use, or it may be a rotary connector of the kind shown and described. Furthermore, the said connector may be of the kind in which provision is made for decreasing the flow of current in the talking circuit when the called line is found to indicate to an operator that the connection has been established, and for then retiring the supervisory signal when the called subscriber answers. Thus two things may be accomplished by the response of the called subscriber, to-wit, the giving of a supervisory signal and the registering of the call, or the operation of any other suitable mechanism for any suitable purpose. Furthermore, it is obvious that the reversal of current in the talking circuit may be accomplished by other suitable means, and not by means in the connector, without departing

from the spirit of my invention. Any automatic switch for use in an automatic or semi-automatic telephone exchange system which has provision for reversing the flow of current in the talking circuit will serve the purpose of my invention. Also, it will be seen that my invention is operative in connection with a system in which the automatic switches are controlled over metallic circuits—that is to say, by controlling the two sides of the calling line in series. Again, it is preferable that my improved system be of the kind in which the current for talking purposes is supplied from a central source, or from one or more central sources, when the call is from one automatic subscriber to another. As shown, however, local batteries may be employed for the manual substations, and it is contemplated that other arrangements may be employed for supplying talking current without departing from the spirit of my invention.

It will be seen that the selectors and connectors of my improved system are of that type in which one motion is employed for selecting a group and another motion for then finding a line in the predetermined group. In the selectors, for example, the vertical motion is employed for selecting a group of trunks corresponding to the digit of any called number, and the rotary motion is then employed for automatically selecting an idle trunk in the predetermined group. In the connectors the vertical motion is employed for selecting a group of subscribers' lines in accordance with a digit of the called number, and the rotary motion is then employed for finding the called line in accordance with another digit of the called number. The system is of the two-wire type, to-wit, a system which is free from operating grounds at the substations thereof. As described and illustrated, the calling connection may be either entirely automatic or semi-automatic, and in the latter case the originating operator has complete supervision of the connection. In either case, however, the call is registered by a measured service device of any suitable character which responds to a reversal of current in the talking circuit when the called subscriber answers. The measured service device may be located at any suitable point in the connection, depending upon the purpose for which it is employed.

In telephone systems giving so-called measured service, it is very often desired that no charge shall be levied for calling certain lines, such as lines which terminate at the central office and over which operators or exchange attendants are called, etc. In systems employing meters which are operated automatically when the called subscriber answers, this requires that special

means be provided to prevent the meter of the calling line from being operated when a call to a free line is answered. This may be very easily accomplished in the system shown herein by making all such lines which are to be called free accessible by special connector switches. This special connector can be merely the ordinary form of two-wire connector—that is, a connector which does not have any provision for reversing the current upon the line. For example, these special connectors may be similar in all respects to the connector I (Fig. 3), with the exception that the windings of the line relay 73 should be connected to the trunk conductors 182 and 184 direct and not through the springs of the relay 81. The relay 81 of these special connectors would then have no springs corresponding to the springs 193, 194, 247, 196, 195 and 246. When any line is called over such a connector, the response at the called substation does not cause the current in the calling line to be reversed, and consequently the meter of the calling line is not operated. Thus, any line in the system can call any line which is accessible from these special connectors without being charged for the call.

What I claim as my invention is:—

1. In a telephone system, a manual switchboard, means including a repeater and a connector for extending connection therefrom, means at the connector and repeater for reducing the current-flow in the talking circuit when the called line is found, a signal at the manual switchboard, which signal is responsive to the reduction of current in the the talking circuit, means for retiring said signal when the called subscriber answers, and a measured service device which is also responsive when the called subscriber answers.

2. In a telephone system, a manual switchboard, means including a repeater and a connector for extending connection therefrom, means in said connector and repeater for reducing the current-flow in the talking circuit when the called line is found, a signal at the manual switchboard, which signal is responsive to the reduction of current in the talking circuit, means for retiring said signal when the called subscriber answers, means for reversing the current-flow in the talking circuit when the called subscriber answers, and registering means responsive to said reversal of the current.

3. In a telephone system, a calling subscriber's line, means including a non-numerical trunk-selecting switch and a connector for extending connection from said line of the line of the called subscriber, said connector adapted to operate in accordance with the last two digits of the called number, a service meter for the calling line, and means

in said connector for controlling said service meter when the called subscriber answers by reversal of current in the calling line.

4. In a telephone system, a calling telephone line, a non-polarized electromagnetic service meter for said line, means including an automatic switch for extending connection from said calling line to the line of the called subscriber, and means in said automatic switch for reversing the flow of current in the two sides of the talking circuit when the called subscriber answers, said service meter being responsive to said reversal of current to register the call.

5. In a telephone system, a calling telephone line, a non-polarized electromagnetic service meter therefor, means including an automatic connector for extending connection from the calling line to the line of the called subscriber, said connector adapted to operate in accordance with two digits of the called number, and means in said connector for reversing the flow of current in the two sides of the talking circuit when the called subscriber answers, said service meter being responsive to the reversal of current to register the call.

6. In a telephone system, a calling line, a called line, suitable means including one or more automatic switches for extending connection from the calling line to the called line, a non-polarized electromagnetic service meter for said calling line, and means for controlling said meter when the called subscriber answers by reversing the current-flow in both sides of the talking circuit.

7. In a telephone system, a calling line, a called line, means controlled entirely by the calling subscriber for extending connection from one line to the other, a non-polarized electromagnetic measured service device for the calling line, and means for controlling said measured service device when the called subscriber answers by reversing the current-flow in both sides of the talking circuit.

8. In a telephone system, a calling line, a called line, means including a manual cord circuit and an automatic switch for extending and completing connection from one line to the other, a measured service device for the calling line, and means for controlling said measured service device when the called subscriber answers by reversing the current-flow in some portion of the talking circuit.

9. In a telephone system, means for extending connection to an operator's cord circuit and automatic means controlled from the cord circuit for extending a call from one line to another, means for supervising the connection, a measured service device individual to said automatic means, and means for operating said device when the called subscriber answers.

10. In a telephone system, a manual switchboard, means including a repeater and a connector for extending connection therefrom, means at the connector and repeater for reducing the current-flow in the talking circuit when the called line is found, a signal at the manual switchboard, which signal is responsive to the reduction of current in the talking circuit, means for retiring said signal when the called subscriber answers, a measured service device which is also responsive when the called subscriber answers, and a central source of talking and operating current.

11. In a telephone system, a manual switchboard, means including a repeater and a connector for extending connection therefrom, means in said connector and repeater for reducing the current-flow in the talking circuit when the called line is found, a signal at the manual switchboard, which signal is responsive to the reduction of current in the talking circuit, means for retiring said signal when the called subscriber answers, means for reversing the current-flow in the talking circuit when the called subscriber answers, registering means responsive to said reversal of the current, and a central source of talking and operating current.

12. In a telephone system, a cord, a trunk leading therefrom, means for extending connection over said trunk to a called subscriber's line, a non-polarized electromagnetic service meter individual to said trunk, means for controlling said service meter when the called subscriber answers, and a central source of talking and operating current energizing current for said meter passing through said cord.

13. In a telephone system, a calling telephone line, a non-polarized electromagnetic service meter for said line, means including an automatic switch controllable over two sides of the line in series for extending connection from said calling line to the line of the called subscriber, means in said automatic switch for reversing the flow of current in the talking circuit when the called subscriber answers, said service meter being responsive to said reversal of current to register the call, and a central source of talking and operating current.

14. In a telephone system, a calling telephone line, a non-polarized electromagnetic service meter therefor, means including an automatic connector controllable over two sides of the line in series for extending connection from the calling line to the line of the called subscriber, said connector adapted to operate in accordance with two digits of the called number, means in said connector for reversing the flow of current in the talking circuit when the called subscriber answers, said service meter being responsive

to the reversal of current to register the call, and a central source of talking and operating current.

15. In a telephone system, a calling line, 5 a called line, suitable means including one or more automatic switches controllable over two sides of the line in series for extending connection from the calling line to the called line, a non-polarized electromagnetic service 10 meter for said calling line, means for controlling said meter when the called subscriber answers by reversing the current-flow in a suitable portion of the talking circuit, and a central source of talking and operat- 15 ing current.

16. In a telephone system, a calling line, a called line, means controlled entirely by the calling subscriber over two sides of the line in series for extending connection from 20 one line to the other, a non-polarized electromagnetic measured service device for the calling line, means for controlling said measured service device when the called subscriber answers by reversing the current- 25 flow in a suitable portion of the talking circuit, and a central source of talking and operating current.

17. In a telephone system, a calling line, a called line, means controllable over two 30 sides of the line in series for semi-automatically extending and completing connection from one line to the other, a non-polarized electromagnetic measured service device for the calling line, means for controlling said 35 measured service device when the called subscriber answers by reversing the current-flow in some portion of the talking circuit, and a central source of talking and operating current.

40 18. In a telephone system, a manual switchboard, means including a repeater and a connector for extending connection therefrom, means at the connector and repeater for reducing the current-flow in the talking 45 circuit when the called line is found, a signal at the manual switchboard, which signal is responsive to the reduction of current in the talking circuit, means for retiring said signal when the called subscriber answers, 50 and a measured service device which is also responsive when the called subscriber answers, said system being free from operating grounds at the substations thereof.

19. In a telephone system, a manual 55 switchboard, means including a repeater and a connector for extending connection therefrom, means in said connector and repeater for reducing the current-flow in the talking circuit when the called line is found, a 60 signal at the manual switchboard, which signal is responsive to the reduction of current in the talking circuit, means for retiring said signal when the called subscriber answers, means for reversing the current- 65 flow in the talking circuit when the called

subscriber answers, registering means responsive to said reversal of the current, and means for operating said switch over two sides of a line circuit in series.

20. In a telephone system, a cord circuit, 70 a trunk line, means for connecting the cord with one end of said line and means including an automatic switch at the other end of said line for extending connection from said trunk to a called subscriber's line, a service 75 meter individual to said trunk and a circuit for said meter comprising said cord, means for controlling said service meter when the called subscriber answers, and means for operating said switch over two sides of a 80 line circuit in series.

21. In a telephone system, a calling telephone line, a non-polarized electromagnetic service meter in said line, means including 85 an automatic switch controllable over two sides of the line in series for extending connection from said calling line to the line of the called subscriber, and means in said automatic switch for reversing the flow of 90 current in the talking circuit when the called subscriber answers, said service meter being responsive to said reversal of current to register the call.

22. In a telephone system, a calling telephone line, a non-polarized electromagnetic 95 service meter therein, means including an automatic connector controllable over two sides of the line in series for extending connection from the calling line to the line of the called subscriber, said connector adapted 1 to operate in accordance with two digits of the called number, and means in said connector for reversing the flow of current in the talking circuit when the called subscriber 1 answers, said service meter being responsive to the reversal of current to register the call.

23. In a telephone system, a calling line, a called line, suitable means including one 1 or more automatic switches controllable over two sides of the line in series for extending connection from the calling line to the called line, a non-polarized electromagnetic serv- 1 ice meter in said calling line, and means for controlling said meter when the called sub- 1 scriber answers by reversing the current-flow in a suitable portion of the talking circuit.

24. In a telephone system, a calling line, a called line, means controlled entirely by 1 the calling subscriber over two sides of the line in series for extending connection from one line to the other, a non-polarized electromagnetic measured service device in the 1 calling line, and means for controlling said measured service device when the called subscriber answers by reversing the current- 1 flow in a suitable portion of the talking circuit.

25. In a telephone system, a calling line, 1

a called line, means including a manual switchboard and an automatic switch for extending and completing connection from one line to the other, said switch being controllable over two sides of a line circuit in series, a non-polarized electromagnetic measured service device in the calling line, and means for controlling said measured service device when the called subscriber answers by reversing the current-flow in some portion of the talking circuit.

26. In a telephone system, a calling telephone line, a service meter for said line, a non-polarized electromagnet therefor, means for energizing said electromagnet over two sides of the calling line in series to operate said meter, means including an automatic switch controllable over two sides of the line in series for extending connection from said line to the line of the called subscriber, means in said automatic switch for controlling said service meter when the called subscriber answers, means for connecting said calling line with other subscribers without causing the operation of said service meter, and common battery means for supplying talking current to the subscribers' lines.

27. In a telephone system, a calling and a called subscriber's line, means including automatic selecting switches and a manual operator's cord circuit for establishing a connection between said lines, a meter for registering calls, a circuit for said meter including two sides of the calling line in series, means for automatically operating said meter upon the response of the called subscriber to register the call by closing said circuit and means for releasing said selecting switches whereby the circuit of said meter may be broken.

28. In a telephone system, automatic switching apparatus for extending a metallic circuit from a calling to a called line, a service meter for the calling line, a release circuit for said automatic apparatus separate from said metallic circuit, said meter being included in both the metallic and in the release circuits and controlled thereover.

29. In a telephone system, a cord circuit, a trunk leading therefrom, means for automatically extending connection from said trunk to a called subscriber's line, a service meter individual to said trunk, and means for automatically controlling said service meter when the called subscriber answers, energizing current for said meter passing via said cord.

30. In a telephone system, a cord circuit, a trunk terminating at said cord circuit in a jack, the other end of which trunk terminates in an automatic switch, means for operating said switch for engaging a second trunk, and automatic means for completing a connection via the second trunk with the called subscriber, a service meter individual

to said first trunk, and means for automatically controlling said service meter when the called subscriber answers.

31. In a telephone system, a trunk line terminating at one end in an automatic switch and terminating in the other in terminals for seizing said switch, means for extending connection to the called line via said terminals and switch, a service meter individual to said trunk, and means for automatically controlling said service meter when the called line is closed.

32. In a telephone system, a calling subscriber's line, means including a non-numerical trunk selecting switch and a connector switch for extending connection from said line to a called line, said connector adapted to operate in accordance with the last two digits of the called number, a service meter for the calling line, a release circuit for said switches separate from the line circuit, said meter being included in both the line and the release circuits, and means in said connector for controlling said service meter when the called subscriber answers.

33. In a telephone system, a calling and a called line, a plurality of automatic switches for connecting the two, one of said switches adapted to operate in accordance with the last two digits of the called number, a service meter for the calling line in the subscriber's line circuit, a release circuit for said switches separate from the line circuit, said meter being included in both the line and the release circuits, and means in said one switch for controlling said service meter when the called subscriber answers.

34. In a telephone system, a calling talking circuit and a called talking circuit, trunking switches for connecting the two into a continuous talking circuit, a meter in series with said talking circuit, a release circuit for said switches separate from the line circuit, said meter being included also in the release circuit, and means in one of said switches for controlling said service meter by closing the called section of the talking circuit after the talking circuits are connected.

35. In a telephone system, a calling talking circuit and a called talking circuit, switches for connecting the two into a continuous talking circuit, a release circuit for said switches separate from the talking circuit, a meter associated with said talking circuit controlled by both the talking and the release circuits, and means for operating said meter by closing the called section of the talking circuit.

36. In a telephone system, a manual switchboard, a trunk terminating and having a terminal therein and leading therefrom, means for extending connection from said trunk to the called subscriber's line, said means controllable over two sides of the

trunk in series, a non-polarized electromagnetic service meter individual to said trunk, means for controlling said service meter when the called subscriber answers, and a
5 central source of talking and operating current.

37. In a telephone system, a calling line, a called line, means for semi-automatically extending and completing connection from one
10 line to the other controllable over two sides of the line in series, a measured service device for the calling line, means for controlling said measured service device when the
15 called subscriber answers by reversing the current-flow in some portion of the talking circuit, and a central source of talking and operating current.

38. In a telephone system, a calling line, a called line, a cord circuit, means for extending
20 and completing connection from one line to another, said means controlled over two sides of said cord circuit in series, a measured service device, means for controlling said measured service device when the called sub-
25 scriber answers by reversing the current flow in some portion of the talking circuit, energizing current for said measured service device passing through said cord, and a central source of talking and operating cur-
30 rent.

39. In a telephone system, a manual circuit, a line, means for connecting the circuit with the line, a meter in the line circuit, automatic equipment for extending connec-
35 tion from the line to another line, means in the manual circuit for supervising the connection, and means for registering the call, said automatic equipment being operated over the two sides of the said line in
40 series.

40. In a telephone system, a manual circuit, a line, means for connecting the circuit with the line, automatic equipment for connecting the line with another line, a release
45 circuit separate from the line for said automatic equipment, means for supervising the connection, a meter in the line and in the release circuit, and means for registering the connection, said automatic equipment being
50 operated over the two sides of the line in series.

41. In a telephone system, a manual circuit, a line, means for connecting the circuit with the line, automatic equipment for connecting the line with another line, a release
55 circuit separate from the line for said automatic equipment, means for supervising the connection, a meter in the line and in the release circuit for registering the connection, said automatic equipment being oper-
60 ated over the two sides of the line in series, said meter operated by a reversal of current in the first line.

42. In a telephone system, a line, means
65 for extending connection from said line to

another line, a release circuit for breaking the connection, a meter for said line having a winding in the line circuit and a meter winding in the release circuit, said meter
70 operated by current in the line circuit and held in an operated position by current in the release circuit.

43. In a telephone system, a line, means for extending connection from said line to
75 another line, a release circuit for breaking the connection, a meter for said line having a winding in the line circuit and a meter winding in the release circuit, means for operating the meter by current in the line circuit and for shunting the meter winding
80 in the line circuit, and means for energizing the winding in the release circuit for holding the meter operated and the line winding shunted.

44. In a telephone system, a line, means
85 for extending connection from said line to another line, a release circuit for breaking the connection, a meter for said line having a winding in the line circuit and a meter winding in the release circuit, means for re-
90 versing the current in the line circuit to operate the meter, and means in the release circuit for preventing the current in the line circuit from operating the meter.

45. In a telephone system, a line, means
95 for extending connection from said line to another line, a meter for said line, a winding for said meter in said line, means for operating said meter to short circuit the winding, an auxiliary circuit, a winding for said
100 meter in said auxiliary circuit, said winding in said auxiliary circuit for holding the said meter operated and the first winding short circuited.

46. In a telephone system, a line, auto-
105 matic switching apparatus for extending connection from said line to another line, a release circuit for breaking the connection, a meter for said line having a winding in the line circuit and a meter winding in the re-
110 lease circuit, said winding in the line circuit for operating the meter, and said meter winding in the release circuit for holding the meter operated.

47. In a telephone system, a line, auto-
115 matic switching apparatus for extending connection from said line to another line, a release circuit for breaking the connection, a meter for said line having a winding in the line circuit and a meter winding in the
120 release circuit, means for operating the meter and for shunting the meter winding in the line circuit, and means for energizing the winding in the release circuit for holding the meter operated and the line winding
125 shunted.

48. In a telephone system, a line, auto-
matic switching apparatus for extending
connection from said line to another line, a
release circuit for breaking the connection, 130

a meter for said line having a winding in the line circuit and a meter winding in the release circuit, means for reversing the current in the line circuit to operate the meter, said meter winding in the release circuit for preventing the current in the line circuit from operating the meter.

49. In a telephone system, a line, automatic switching apparatus for extending connection from said line to another line, a meter for said line, a winding for said meter in said line, means for operating said meter to short circuit the winding, a release circuit, a winding for said meter in said release circuit for holding the said meter operated and the first winding short circuited.

50. In a telephone system, a first circuit associated with a battery, an impulse sender, a relay, a meter, a second circuit associated with a battery and with said first circuit, said relay responsive to impulses of current flowing over the first circuit from said battery in a given direction, said impulses produced by said impulse sender, said relay controlling said second circuit for repeating impulses therein from the first circuit, and means associated with said second circuit and controlled thereover for reversing the flow of current in said first circuit for operating said meter.

51. In a telephone system, a first circuit associated with a battery, an impulse sender, a relay, a meter and a second circuit associated with said first circuit, said relay responsive to impulses of current flowing over the first circuit from said battery induced by said impulse sender, said relay controlling the said second circuit for repeating impulses therein from the first circuit, and means associated with said second circuit and controlled thereover for operating said meter over the first circuit.

52. In an automatic telephone system, a first circuit, a second circuit, a meter in the first circuit, means for producing impulses in the first circuit and for repeating them in the second circuit, and means controlled over the second circuit for operating the meter over the first circuit.

53. In a telephone system, a calling and a called line, a meter having a winding in the calling line, said meter responsive only to current flow in one direction, means controlled by the calling subscriber for causing intermittent current impulses in the calling line in the wrong direction to operate said meter, means responsive to said impulses for connecting said lines, and means for then causing the current flow in the calling line in the opposite direction whereby said meter may be operated.

54. In a telephone system, a calling and a called line, a meter for the calling line, a source of current in series with the calling line, automatic switching mechanism re-

sponsive to interruptions of the calling line for connecting said lines, and means for operating said meter by reversal of current flow in said calling line.

55. In a telephone system, the combination with a talking connection between a calling and a called line, a source of talking current, a meter for the calling line having an operating winding in said circuit, means for preventing the operation of said meter when the flow of current in said circuit is in one direction, and means for reversing the flow of current in said circuit to operate said meter.

56. In a telephone system, the combination of a calling and a called line, a talking connection between said lines including one or more automatic switches, a source of talking current, a relay in series with the calling line and said source of talking current for preventing the release of said switches, a meter having a winding in the calling line, said meter unresponsive to normal current in said line, and means for reversing the flow of current in the calling line to actuate said meter.

57. In a telephone system, a calling subscriber's line, means including a non-numerical trunk selecting switch and a connector for extending connection from said line to the line of the called subscriber, said connector adapted to operate in accordance with the last two digits of the called number, a service meter for the calling line provided with a plurality of windings, an armature, a registering mechanism operated by said armature, and means operated by said armature for short circuiting one of said windings, and means in said connector for controlling said service meter when the called subscriber answers by reversal of current in the calling line.

58. In a telephone system, an automatic switching apparatus for extending a metallic circuit from a calling to a called line, a release circuit for said apparatus separate from said metallic circuit, a service meter for the calling line provided with a plurality of windings, an armature therefor, a registering mechanism operated by said armature, a core common to said windings, said windings and core constituting an electromagnet, and means for short circuiting one of said windings when the armature is attracted, said meter having a winding in said metallic circuit and another winding in said release circuit and controlled thereover.

59. In a telephone system, automatic switching apparatus for extending a talking circuit from a calling to a called line, a release circuit for said apparatus separate from said talking circuit, a service meter for the calling line provided with a plurality of windings, an armature, a registering mechanism operated by said armature,

and means operated by said armature for rendering inoperative one of said windings, said meter being included in both the talking and release circuits and controlled there-
5 over.

60. In a telephone system, an automatic switching apparatus for extending a talking circuit from a calling to a called line, a release circuit for said apparatus separate
10 from said talking circuit, a service meter for the calling line provided with an electromagnet having a plurality of windings, an armature therefor, neither winding being
15 windings being sufficient by their cumulative effect to energize said magnet and attract said armature, means operated by said armature for rendering inoperative one of said
20 windings, the other winding being sufficient to hold the armature in its attracted position, a registering mechanism operated by said armature, said meter having a winding

included in the talking circuit and another winding included in the release circuit and controlled thereover.

61. In a telephone system, automatic switching apparatus for extending a talking circuit from a calling to a called line, a release circuit for said apparatus separate
25 from said talking circuit, a service meter for the calling line provided with a plurality of cumulative windings, an armature, a registering mechanism operated by said armature, means operated by said armature
30 for rendering one of said windings inoperative, said meter being included in both the talking and release circuits and controlled thereover.

Signed by me at Chicago, Cook County, Illinois, this 27th day of April, 1910.

TALBOT G. MARTIN.

Witnesses:

ARTHUR J. RAY,
EDWARD D. FALES.