J. ERICKSON.

MEASURED SERVICE TELEPHONE SYSTEM.

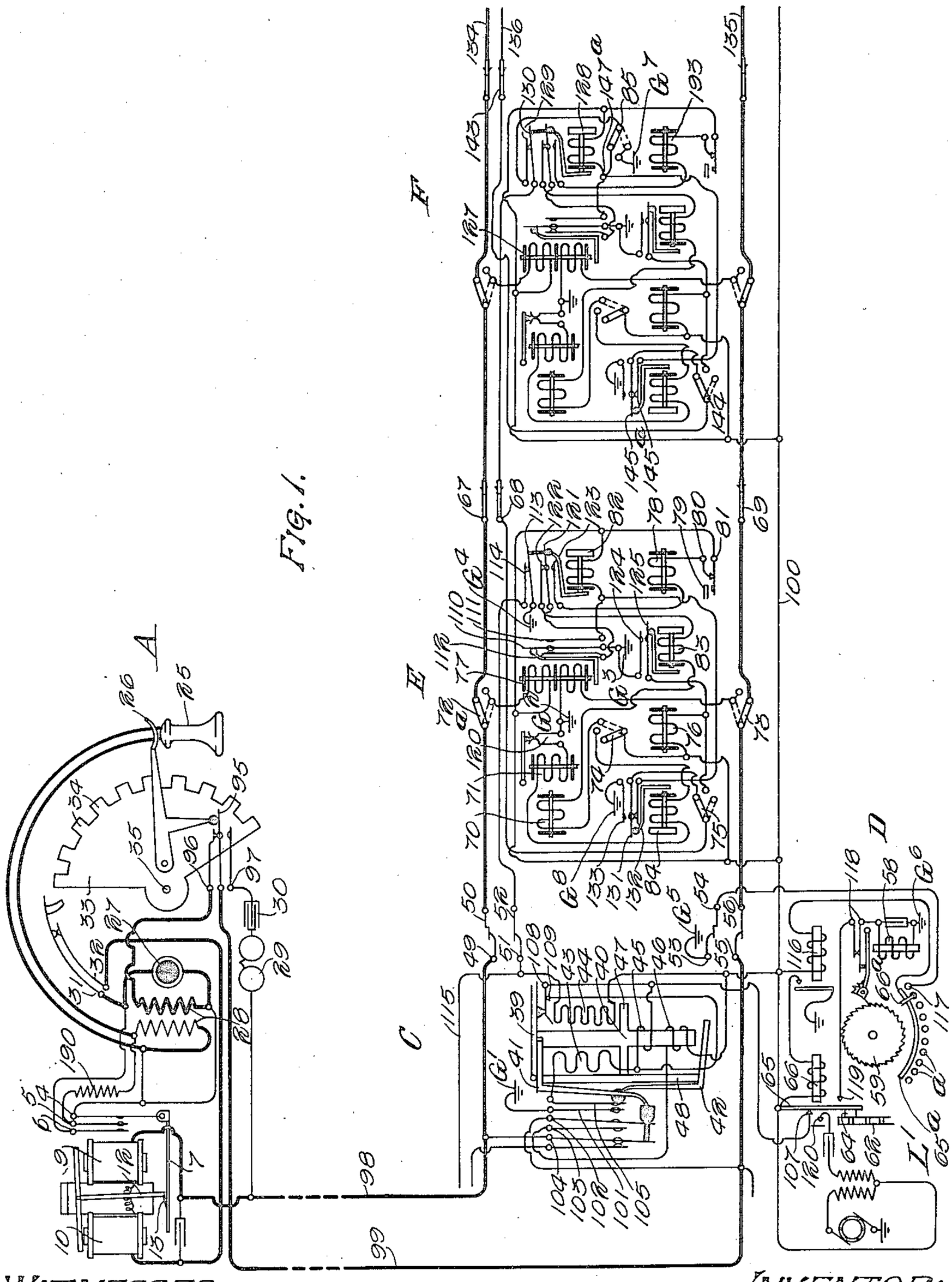
APPLICATION FILED AUG. 5, 1910.

1,225,603.

Patented May 8, 1917.

4 SHEETS—SHEET 1.

FIG. 1.



WITNESSES

A. Andersen.

J. E. Cooley

INVENTOR:

John Erickson

By Buckley & Durand

ATTORNEYS,

J. ERICKSON.

MEASURED SERVICE TELEPHONE SYSTEM.

APPLICATION FILED AUG. 5, 1910.

1,225,603.

Patented May 8, 1917.

4 SHEETS—SHEET 2.

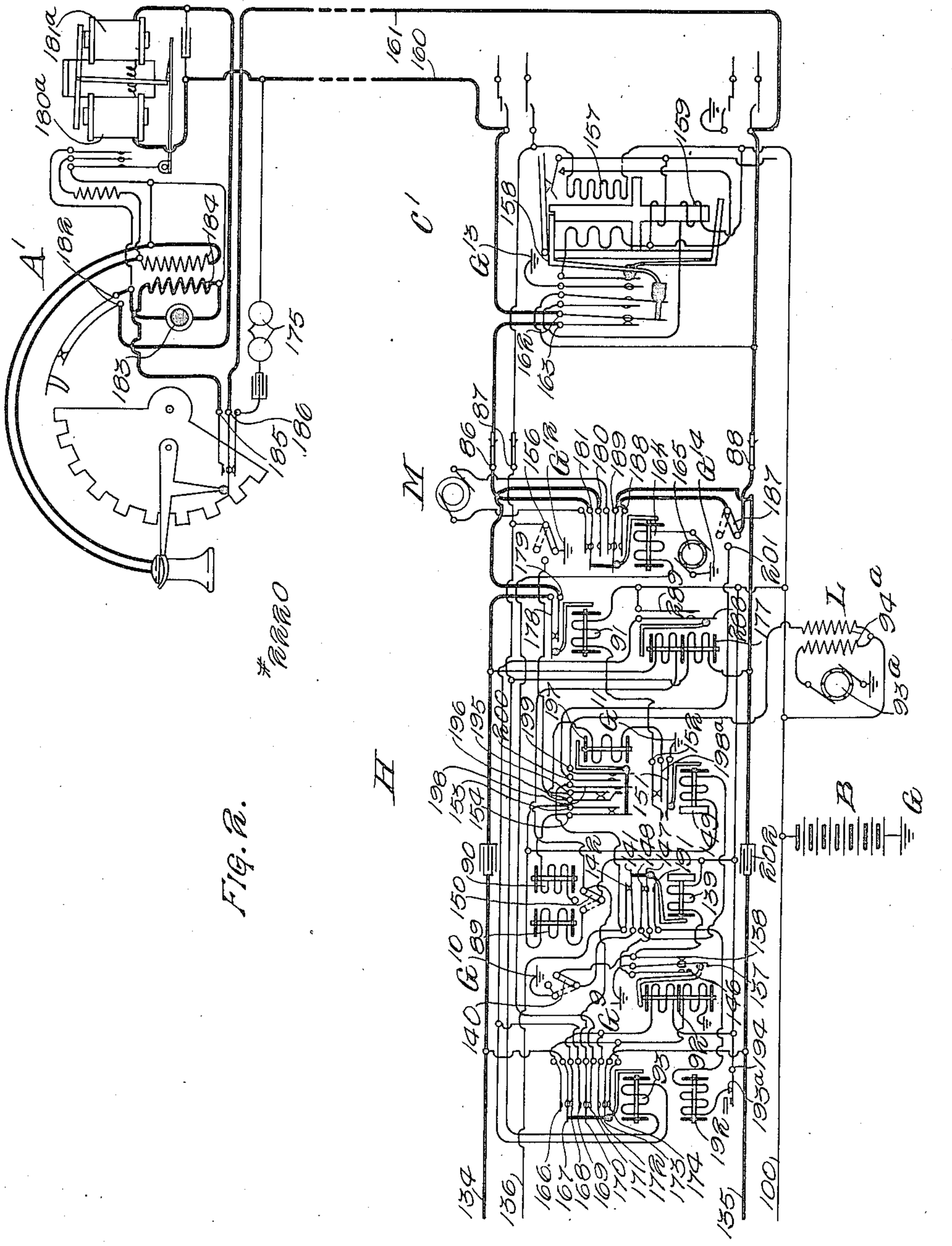


FIG. 2.

WITNESSES

A. Andersen.

J. E. Cooley

INVENTOR:

John Erickson

By Bulkley & Durand

ATTORNEYS.

J. ERICKSON.

MEASURED SERVICE TELEPHONE SYSTEM.

APPLICATION FILED AUG. 5, 1910.

1,225,603.

Patented May 8, 1917.

4 SHEETS—SHEET 3.

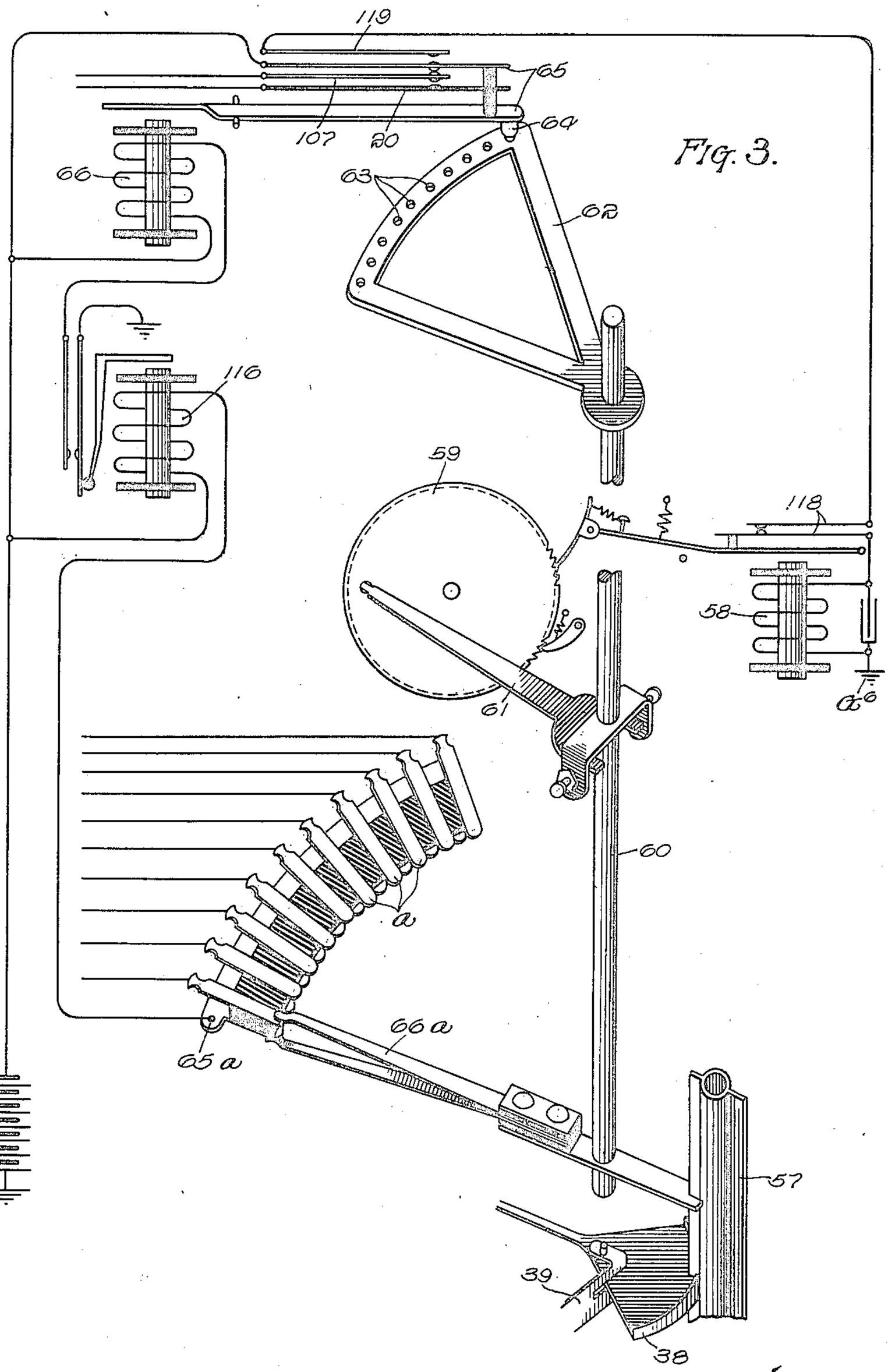


FIG. 3.

WITNESSES

Chas. Hu. Eandy.

H. H. Owen.

INVENTOR:

John Erickson

by Fales

ATTORNEY.

J. ERICKSON.

MEASURED SERVICE TELEPHONE SYSTEM.

APPLICATION FILED AUG. 5, 1910.

1,225,603.

Patented May 8, 1917.

4 SHEETS—SHEET 4.

FIG. 7.

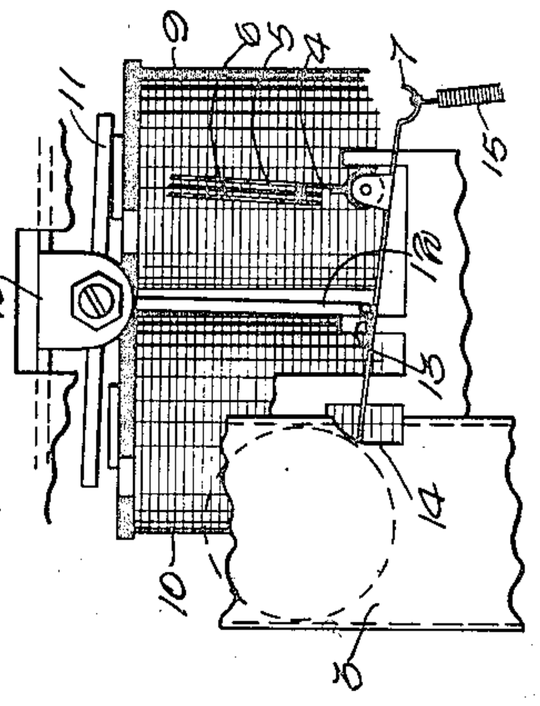


FIG. 8.

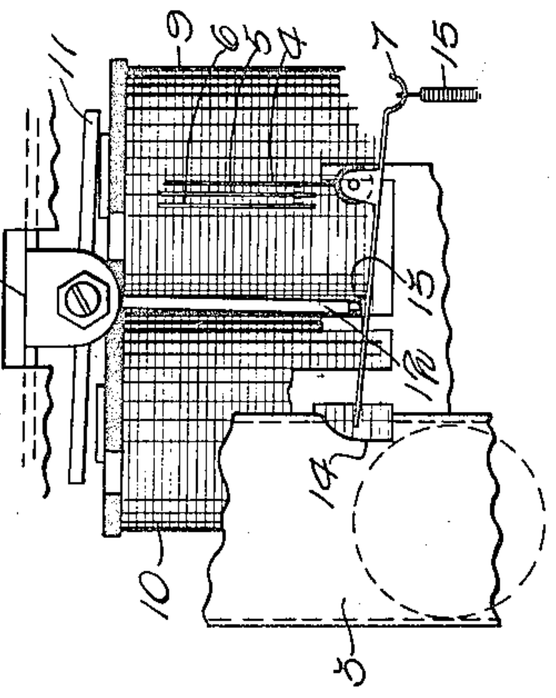


FIG. 6.

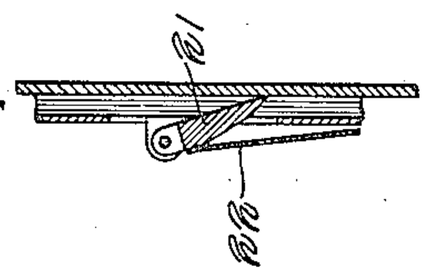


FIG. 5.

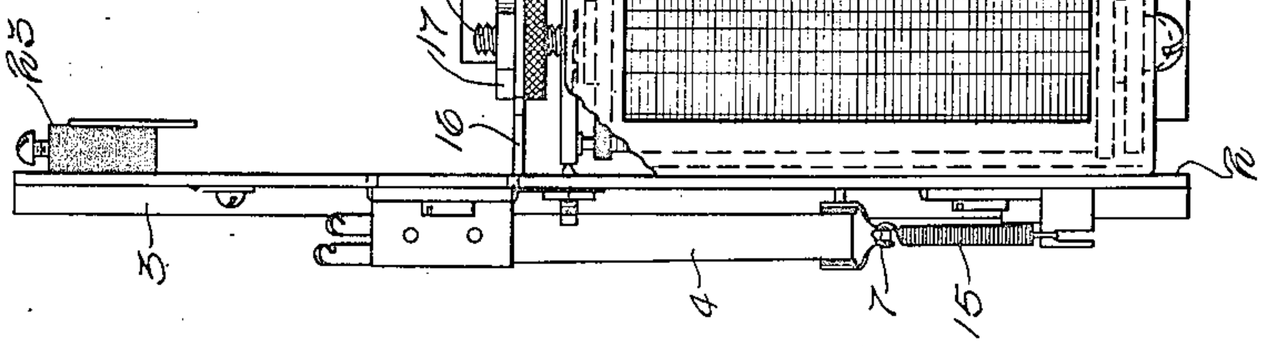
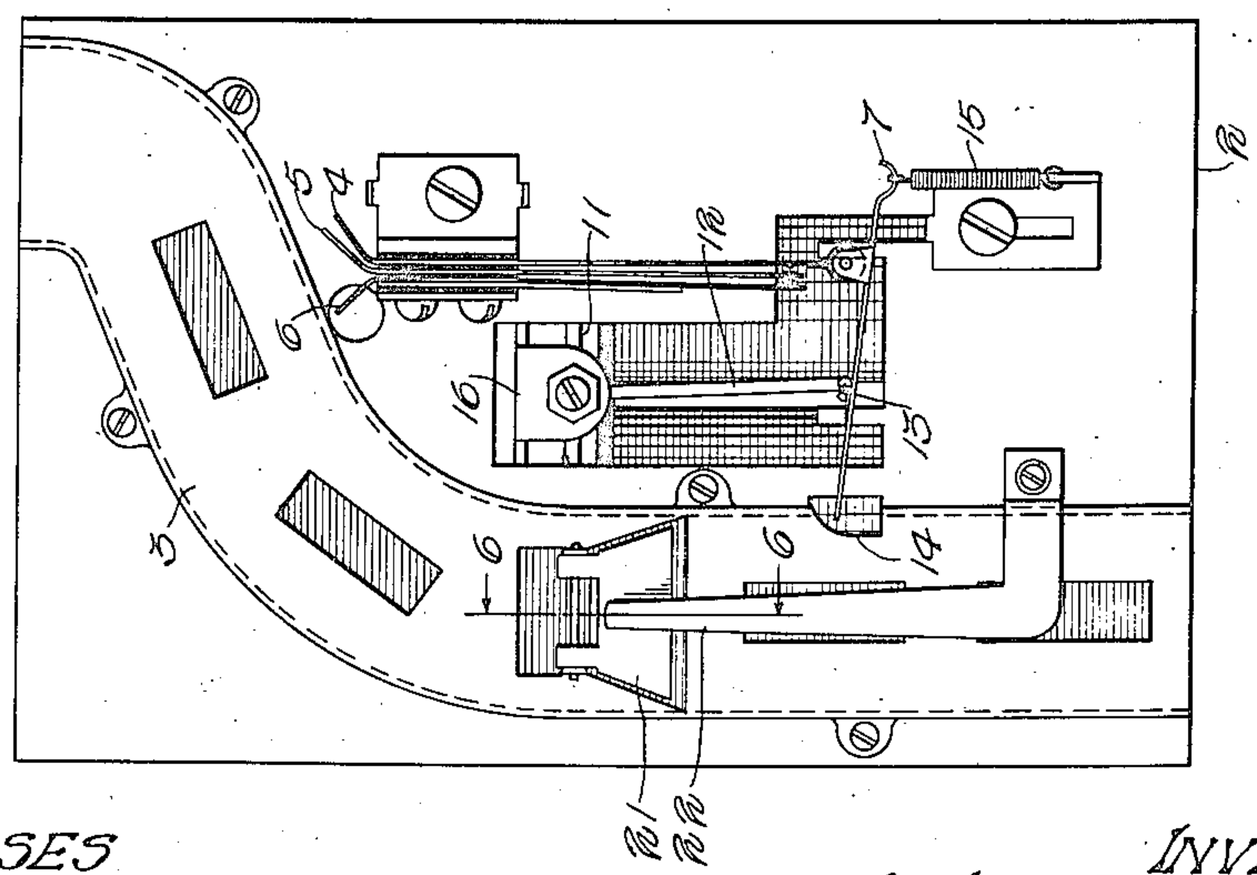


FIG. 4.



WITNESSES

A. Andersen.

J. E. Cooley.

INVENTOR:

John Erickson

By Buckley & Durand

ATTORNEYS

UNITED STATES PATENT OFFICE.

JOHN ERICKSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

MEASURED-SERVICE TELEPHONE SYSTEM.

1,225,603. Specification of Letters Patent. Patented May 8, 1917.

Application filed August 5, 1910. Serial No. 575,751.

To all whom it may concern:

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

My invention relates to telephone systems in general, but more particularly to automatic or semi-automatic telephone systems, and especially to measured service systems.

The principal object of my invention is to provide a novel and efficient measured service arrangement for two-wire systems, and by this is meant a system in which the two sides of the calling line are controlled in series to operate and release the switches at the exchange or central station, as will hereinafter more fully appear.

In the accompanying drawings Figures 1 and 2 represent a complete connection between a calling substation A (Fig. 1) and a called substation A′ (Fig. 2) in a system embodying the principles of my invention. In Fig. 1 there is represented an automatic substation A to the line conductors of which there is allotted at the central office an individual or line switch C. At D there is shown a master switch for controlling a group of line switches C. The line switches of this group have common access to a number of trunk lines which lead to first selector switches E. A number of first selectors have common access to a number of second selectors F, which in turn have access to connector switches H (Fig. 2) by means of which connection may be completed with subscribers' lines.

Fig. 3 is a diagrammatic view of a portion of the central office apparatus, showing the essential features of the master switch D (Fig. 1).

Fig. 4 is a front elevation of my improved substation coin-collecting device.

Fig. 5 is a side elevation of the apparatus shown in Fig. 4.

Fig. 6 is a partial sectional view on the line 6—6 of Fig. 4.

Figs. 7 and 8 are views of portions of the coin-collecting device in different operated positions.

As thus illustrated, the construction and method of operation of the coin-collecting device is as follows: In Figs. 4 and 5 a face plate 2 is shown to the front surface of which there is attached a coin chute 3. Also, to the front of the plate 3, but insulated therefrom and from each other, there is mounted a group of contact springs 4, 5 and 6. The lower end of the spring 4 carries a swinging arm 7. Back of the plate 2 there is mounted a polarized electromagnet comprising a permanent magnet 8 and two coils 9 and 10. The armature 11 of the electromagnet is provided with a downwardly-projecting arm 12. The lower end of the arm 12 is bent forward above the arm 7. When the armature 11 is tipped downward to the right, the end of the arm 12 engages a small lug 13 on the top of the arm 7 and carries said arm to the left. When the arm 7 is thus moved to the left its left end projects into an opening 14 in the side of the coin chute, while the spring 4 is forced into engagement with the springs 5 and 6. If a coin is dropped down the chute while the arm 7 is in this position, the coin will strike the end of said arm, carrying the lug 13 out of engagement with the arm 12, whereby the springs 4, 5 and 6 are permitted to separate. Fig. 7 shows the position of the apparatus just before the coin strikes the arm 7. Fig. 8 shows the apparatus after the arm 7 has been disengaged from the arm 12 by the coin. The spring 15 serves to hold the arm 7 in engagement with the arm 12 until the coin is deposited. After the arm 7 has been released it cannot be drawn over again until the electromagnet has been energized in the reverse direction to bring the arm 12 behind the lug 13 again.

The armature of the electromagnet is pivoted to the bracket 16, which is clamped between two pairs of nuts 17 and 18 on screws 19 which project from the top of the side brackets 20. With this method of mounting the armature is easily adjustable toward or away from the poles of the magnet.

Mounted in the front wall of the coin chute is a gate 21 the lower end of which is forced against the back wall of the chute by the spring 22, as shown in Fig. 6. When a coin is dropped in the chute it forces the gate out and passes on with but little obstruction. If, however, a wire or anything of a similar nature should be inserted in the chute for the purpose of fraudulently operating the arm 7, the gate 21 acts as a clutch and seizes the wire when an attempt is made

to withdraw it. Electrical connections are made with the coin device by means of binding posts in the block 23.

The automatic substations may be of any suitable or approved type. Those in connection with which I have elected to illustrate my invention, as shown at A in Fig. 1, comprise the usual receiver 25, switch hook 26, transmitter 27, induction coil 28, ringer 29 and condenser 30. In addition the substation A is provided with the impulse springs 31 and 32 and an impulse wheel 33. The impulse wheel 33 carries upon its periphery the impulse teeth 34 and is secured to a shaft 35 to which there is also attached a dial (not shown) provided with finger holes, through the medium of which the impulse wheel may be rotated. As the impulse wheel is returned to normal position by a spring (not shown) after it has been rotated for any digit, each of the teeth 34 which pass the end of spring 31 forces said spring out of engagement with spring 32. The number of times these springs are separated depends upon the digit called. Connected to the line of substation A there is also shown one of my improved coin-collecting devices. The coin-collecting device is represented only diagrammatically in Fig. 1 and the parts are designated by the same reference numerals as in Figs. 4 and 5.

The line switch C, which is individual to the line of substation A, and the master switch D are modified forms of the general type of line switch and master switch disclosed in British Patent #26,301 of 1906, and in the *American Telephone Journal* of New York, N. Y., of June 6, 1908. As herein represented, the line switch C comprises, among other details, a plunger 38 (Fig. 3) attached to the end of a so-called plunger arm 39 which is controlled by the magnet 40. The magnet 40 also controls the relay armatures 41 and 42 and is composed of four windings, namely, a pull-in winding 43, a holding or cut-off winding 44, line winding 46 and an auxiliary winding 45. The core of the magnet is provided near the center of its length with a lateral projection 47 by means of which the magnet is mounted upon the bracket 48, upon which latter the armatures 39, 41 and 42 are pivoted. With this method of mounting the magnet, the magnetic circuit of the windings 43 and 44 is maintained separate from that of the windings 45 and 46, so that the armatures at one end of the magnet are not affected by the energization of the windings upon the other end. Of the two windings upon the upper end of the magnet, only the winding 43 is strong enough to attract the plunger arm 39 from its normal position. The winding 44 is not strong enough to thus operate the plunger arm, but will hold it in an operated position after it has been drawn down by the winding 43. When the plunger arm 39 is attracted by the magnet 40 the plunger of the switch is forced into a bank of contact springs, forcing springs 49, 51, 53 and 55 into engagement with springs 50, 52, 54 and 56, respectively. Although only one set of springs 49—56 is shown, each line switch C is provided with a number of such groups of springs, each group forming the terminal of a trunk line leading to a selector E. Each trunk line is multiplied through the corresponding springs of all the line switches of the group which is controlled by the master switch D. The plungers of the line switches of this group normally engage the plunger shaft 57 (Fig. 3) and, through the medium of the master switch D, are normally maintained opposite the terminal of an idle trunk line. The master switch consists essentially of a motor magnet 58 for rotating the ratchet wheel 59. The ratchet wheel 59 is connected with the shaft 60 by means of a link 61 in such a manner that a rotary motion of the ratchet wheel is transmitted to the plunger shaft 57, imparting to it an oscillating motion about the shaft 60, so as to move the idle plungers back and forth in front of their trunk terminals. To the shaft 60 there is secured a locking plate 62 provided near its outer edge with a number of openings 63 which are adapted to be engaged by the pin 64 upon the end of the armature 65 of the relay 66. The openings in the plate 62 are so spaced that the pin 64 can engage one of them only when the plungers that are in locking engagement with the plunger shaft are directly in front of the corresponding trunk terminal. The master switch is also provided with a bank of contacts comprising a common segment 65^a and one individual segment *a* for each trunk to which the line switches have access. The wiper 66^a always keeps the common segment in electrical connection with the individual segment corresponding to the trunk line before which the idle plungers are being held by the master switch.

The selector E is of the general type of selector disclosed in United States Letters Patent #815,321, granted to Keith, Erickson and Erickson, March 13, 1906, being somewhat modified, however, so as to operate in a two-wire system, *i. e.*, a system in which the central office apparatus is controlled from the calling substation over the two sides of the line in series. As herein represented, the selector E comprises the usual wipers 67, 68 and 69 carried upon a vertically and rotatably movable shaft (not shown) which is controlled by the vertical magnet 70 and rotary magnet 71. The usual side switch, comprising the wipers 72, 73, 74 and 75, is controlled by the private magnet 76 in a well known manner. The opera-

tion of the selector is controlled by the calling subscriber through the medium of the double-wound line relay 77. Means for restoring the mechanism of the selector to normal position is provided in the release magnet 78, which is connected with the battery only when the switch shaft is raised one or more steps, whereby the arm 79, which is carried by said shaft, permits the spring 81 to engage spring 80. The mechanism of the selector E is released immediately upon the energization of the release magnet rather than by its deënergization, as shown in the said selector patent. The relays 82, 83 and 84 are slow acting relays, *i. e.*, they are slow to deënergize after their energizing circuits have been broken. This slow action is usually accomplished by securing a heavy ring of copper around one end of the core of the relay. The selector F is similar to the selector E with the addition of side switch wiper 85.

The connector H is of the general type of connector switch disclosed in United States Letters Patent #815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but, like the selectors, is modified in order to operate in a two-wire system. Like the selectors, the connector is provided with a shaft (not shown) carrying the wipers 86, 87 and 88, and is controlled by the vertical magnet 89 and rotary magnet 90. The usual side switch is controlled by the private magnet 91 in the usual manner. The line relay 92 is connected with the line conductors through the springs of a reversing relay 93. The connector is provided with a so-called back bridge relay 177 through which the called substation is provided with talking battery current, and with a ringer relay through the medium of which ringing current may be applied to the called line after connection is completed therewith.

The substation A′ and line switch C′ are similar to the substation A and line switch C, respectively. At M there is shown a ringing current generator and at L is shown a busy signaling machine comprising a current interrupter 93^a and an induction coil 94^a. For operating the central office apparatus and for furnishing talking current there is provided a battery B having one pole (preferably the positive) grounded at G.

Having given a general description of the apparatus, I will now explain in detail the operations by which one subscriber establishes connection with another in a system embodying the principles of my invention. It will be explained how substation A may obtain connection with substation A′, the number of which is assumed to be 2220. When the calling subscriber removes his receiver preparatory to making a call the switch hook rises, permitting the spring 95 to pass out of engagement with spring 97 and into contact with spring 96, whereby the circuit of the ringer 29 and condenser 30 is broken, and a bridge consisting of the substation transmitter, primary winding of the induction coil and the windings of the coin-collecting device is closed across the line conductors 98 and 99. The closure of this bridge across the line completes an energizing circuit through the line winding 46 of the switch C. This circuit extends from ground G′ through springs 101 and 102, line 99, springs 95 and 96, primary winding of induction coil 28, impulse springs 31 and 32, coils 10 and 9 of the coin-collecting device, line 98, springs 104 and 103 and winding 46 to battery lead 100. The current through the coils of the coin-collecting device at this time flows in such a direction as to attract the armature toward coil 10, as shown in Fig. 1, thereby bringing the end of arm 12 into engagement with the lug 13 on the arm 7. The energization of the winding 46 serves to attract the armature 42, which operates to force the spring 105 into engagement with spring 101, whereby a circuit is closed through the pull-in winding 43. This circuit extends from ground G′ through springs 101 and 105, windings 43 and 45, contact point 107 and armature 65 to battery lead 100. The winding 43, upon energizing, attracts the armature 41 and plunger arm 39. The armature 41, upon being attracted, operates to disconnect the line winding 46 and ground G′ from the calling line. The armature 42 does not fall back immediately upon the deënergization of the winding 46, but remains held up by current flowing in the winding 45 until the plunger arm 39 forces spring 108 into contact with spring 109, whereby the winding 45 is short-circuited and consequently deënergizes slowly to hold the armature 42 in its operated position for an instant longer. Before the armature 42 is restored sufficiently to break the circuit of winding 43 a circuit is closed through the winding 44 in the following manner: When the springs 49 and 55 are forced into contact with springs 50 and 56, respectively, by the plunger of the line switch C a circuit is closed through the line relay 77 of the selector E. This circuit extends from ground G^2 through lower winding of relay 77, side switch wiper 73, springs 56 and 55, thence over the heavy conductors to and through substation A and back over the other side of the line through upper winding of relay 77 to the battery lead 100. The relay 77, upon energizing, operates to close a circuit through the relay 82, said circuit extending from ground G^3 through springs 110 and 111 and relay 82 to battery lead 100. The relay 82, upon energizing, operates to close the circuit of the holding winding 44 of the line switch C, said

circuit extending from ground G^4 through springs 113 and 114, 52 and 51 and winding 44 to battery lead 100. The current in this winding serves to hold the plunger arm 39 and armature 41 in their operated positions after the winding 43 has been deënergized. The energization of the relay 82 at the selector E also extends a guarding potential from ground G^4 over conductor 115 to the connector private bank contacts of the calling line.

When the springs 53 and 54 are forced into contact by the plunger of the line switch, a circuit is closed through the master switch relay 116. This circuit extends from ground G^5 through springs 53 and 54, contact point 117, wiper 66^a, segment 65^a and relay 116 to battery lead 100. The relay 116, upon energizing, operates to close a circuit through the relay 66. The relay 66, upon energizing, operates to withdraw the pin 64 from the plate 62 and to close the circuit of the motor magnet 58. This circuit extends from ground G^6 through magnet 58, interrupter springs 118, contact point 119 and armature 65 to battery lead 100. As long as the armature 65 engages contact point 119, the magnet 58 operates in a manner similar to that of a buzzer to rotate the ratchet wheel 59 step by step to advance the idle line switch plungers away from the trunk just seized. After the plungers have been advanced a short distance, the wiper 66^a passes off the contact point 117 and allows the relays 116 and 66 to deenergize. The armature 65 does not fall back immediately upon the deënergization of relay 66, but remains in contact with contact point 119 until the next opening in the plate 62 passes under the pin 64. When the next opening does pass under the pin 64 the armature 65 falls back, forcing the pin into this opening to lock the plunger shaft and breaking the circuit of the motor magnet 58. The foregoing is the operation of the master switch in case the next trunk line after the one seized by the switch C is idle. If, however, this next trunk is busy, the wiper 66^a finds the corresponding contact in the master switch bank grounded, and consequently the relays 116 and 66 remain energized while the next opening is passing under the pin 64 and the plungers are carried past the busy trunk to an idle one. As long as the master switch is operating, the armature 65 is disengaged from the spring 107 and spring 107 engages spring 120, whereby the pull-in windings of all the idle line switches are disconnected from the battery and connected to the busy signaling machine L'. With this arrangement no line switch can be operated while its plunger is being moved from one trunk to another, and any subscriber who attempts to make a call at that time will receive the busy signal, due to the inductive relation between the line winding 46 and the winding 45, which is then connected to the busy signaling machine L'.

The foregoing are the operations which take place immediately upon the removal of the receiver at the calling substation. The calling subscriber now operates his calling dial in the usual manner for the first digit 2 of the desired number. As the impulse wheel 33 returns to normal position after being rotated for this digit, the impulse springs 31 and 32 are separated twice momentarily. Each time the springs 31 and 32 are separated, the energizing circuit of the line relay 77 of the selector E is broken, allowing said relay to be momentarily deenergized. Since the relay 82 of the selector is slow acting, it does not have time to deenergize during the momentary interruption of its circuit at the springs 111 and 110. Consequently, the engagement of springs 110 and 112 closes an energizing circuit through the vertical magnet 70. This circuit extends from ground G^3 through springs 110 and 112, springs 121 and 122, private magnet relay 83, vertical magnet 70 and the side switch wiper 74 to battery lead 100. Since the digit called is 2, the vertical magnet receives two impulses over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts. The private magnet relay 83 which is included in the energizing circuit of the vertical magnet is energized with the first impulse, but being a slow acting relay does not have time to deënergize until the last impulse for the digit is transmitted. In its energized condition the relay 83 operates to close a circuit extending from ground G^3 through springs 124 and 125 and private magnet 76 to battery lead 100. When the relay 83 deënergizes, after the last impulse is transmitted to the vertical magnet, this circuit through the private magnet is broken. The private magnet thereupon deenergizes and allows the side switch to pass to second position. The movement of the side switch wiper 74 from first to second position disconnects the battery from the vertical magnet 70 and completes an energizing circuit through the rotary magnet 71. This circuit extends from ground G^2 through the interrupter springs 120^a, rotary magnet 71, relay 84 and side switch 74 to battery lead 100. Upon the closure of this circuit the rotary magnet attracts its armature, which operates to rotate the shaft wipers one step, to press down the armature of the private magnet 76 and to open the circuit of its own magnet at the interrupter springs 120^a. When the circuit of the rotary magnet is thus opened, its armature falls back and, if the first trunk line upon which the wipers

have just been rotated is not already in use, the private magnet armature also falls back and permits the side switch to pass to third position. If, however, the first trunk line of the second level is already busy, the private wiper 68 finds the first contact which it engages provided with a guarding ground potential. When the wiper 68 thus engages the grounded contact, the locking circuit is completed through the side switch wiper 75 (in second position) and the private magnet 76 to battery lead 100. The private magnet thus becomes energized and locks the side switch in second position. As long as the side switch remains thus locked, the rotary magnet continues to operate in a manner similar to that of a buzzer to rotate the selector wipers step by step until an idle trunk line is found. When the private wiper 68 engages the non-grounded contact of an idle trunk, the private magnet 76 deenergizes and permits the side switch to pass to third position, thereby breaking the circuit of the rotary magnet. The movement of the side switch wipers 72 and 73 from second to third position disconnects the line relay 77 from the line and extends the line connection through the shaft wipers 67 and 69 to the second selector F. The line relay 127 in the selector F then becomes energized in the same manner in which the relay 77 of the selector E was energized when the connection was first extended through that selector. The energization of the relay 127 serves to close an energizing circuit through the slow acting relay 128 in the same manner in which the circuit of relay 82 was closed by the relay 77. The relay 128, upon energizing, extends the guarding potential from ground G^7 to side switch wiper 85 and springs 129 and 130 and to the private bank contacts of the seized trunk in the banks of all of the selectors E which have access to this trunk. A circuit also extends from the ground G^7 through the said selector private bank contacts, private wiper 68, side switch wiper 75, springs 131 and 132 and relay 82 to battery lead 100. This circuit prevents the relay 82 from deënergizing after its former circuit is broken by the deënergization of the relay 77 when the side switch of the selector E passes to third position. A short period of time elapses between the time when the side switch of the selector E passes to third position and the time when the relay 128 energizes to extend a guarding potential back to the first selector private bank contacts from the ground G^7. During this interval the trunk line leading to the selector F is guarded by a ground potential extending from ground G^8 through the springs 133 and 131, side switch wiper 75 and private wiper 68 to the private bank contacts. It will be remembered that the relay 84 is included in the operating circuit of the rotary magnet 71 and, since it is a slow acting relay, it remains energized for an instant after the rotary magnet is energized for the last time. This the relay 84 is already energized when the side switch reaches third position, and a guarding potential is extended from ground G^8 in the manner described. The relay 84 is quicker than the relay 82 and thus deënergizes in time to close the new energizing circuit for the relay 82 before it has time to deënergize.

The calling subscriber now operates his calling device for the second digit 2. The second selector F operates in response to the impulses for this digit in the same manner as explained for the selector E, and extends connection to an idle connector H over the trunk lines 134 and 135. When the connection is thus extended to the connector H its line relay 92 becomes energized in the same manner that the selector line relays are energized. The relay 92, upon energizing, operates to complete a circuit extending from ground G^9 through springs 137 and 138 and the slow acting relay 139 to battery lead 100. The relay 139, upon energizing, extends the guarding potential from ground G^{10} through side switch wiper 140, springs 141 and 142 and conductor 136 to all of the selector private bank contacts which belong to the trunk line leading to the connector H. The energization of the relay 139 of the connector also provides a new holding circuit for the release relays 128 and 82 of the selectors F and E, respectively. This circuit extends from ground G^{10} through side switch wiper 140, springs 141 and 142, conductor 136, private wiper 143 of the selector F, side switch wiper 144 and springs 145 and 145^a to point 147^a. From point 147^a one branch of this circuit extends through the relay 128 to battery, while another branch extends through the side switch wiper 85 (in third position) to and through the relay 82 of selector E over a circuit which has already been traced.

The calling subscriber now operates his dial for the third digit 2, momentarily separating the impulse springs 31 and 32 in the same manner as described for the first digit. Each time the impulse springs are separated for the third digit, the energizing circuit for the connector line relay 92 is broken momentarily. Since the relay 139 of the connector is slow acting it does not have time to deënergize during the momentary deënergization of the relay 92: consequently the engagement of springs 137 and 146 completes an energizing circuit through the vertical magnet 89. This circuit extends from ground G^9 through the springs 137 and 146, springs 147 and 148, private magnet relay 149, vertical magnet 89 and side switch wiper 150 to battery lead 100. The vertical

magnet receives two impulses over this circuit and operates to raise the shaft wipers 86, 87 and 88 two steps. The private magnet relay 149 operates in the same manner as the private magnet relay 83 of the selector E to close the circuit of the private magnet while the vertical magnet is operating. The circuit through the private magnet extends from ground B^{11} through springs 151 and 152 and private magnet 91 to battery lead 100. This circuit is broken shortly after the last impulse is delivered to the vertical magnet, whereupon the private magnet deënergizes and permits the side switch to pass to second position. The movement of the side switch wiper 150 from first to second position transfers the battery connection from the vertical magnet 89 to the rotary magnet 90. The connector is then in position to receive impulses for the last digit 0. The operation of the substation calling device for this digit breaks the energizing circuit of the relay 92 ten times. Each time the relay 92 deënergizes it completes a circuit extending from ground G^9 through springs 137, 146, 147 and 148, relay 149, springs 153 and 154, rotary magnet 90 and side switch 150 (in second position) to the battery lead 100. The rotary magnet 90 receives ten impulses over this circuit and operates to rotate the wipers ten steps onto the contacts of line No. 2220. The private magnet relay 149 is energized by the first impulse to the rotary magnet and again closes the circuit of the private magnet 91. The circuit of the relay 149 is not opened long enough to permit it to deënergize until after the last impulse has been delivered to the rotary magnet. The relay 149 then deënergizes and breaks the circuit of the private magnet 91 which, if the called line is not already busy, in turn deënergizes and permits the side switch to pass to third position, whereby connection is completed between the calling and called lines. The side switch wiper 156 (in third position) extends the guarding potential from ground G^{12} through the private wiper 87 to the connector private bank contacts of the called line, and also provides an energizing circuit for the cut-off winding 157 of the line switch C'. The winding 157, upon energizing, attracts the armature 158, which operates to disconnect the line winding 159 and ground G^{13} from the called line, and to extend the line conductor 160 through the springs 162 and 163 to the connector bank contact which is engaged by wiper 86. When the side switch wiper 150 of the connector reaches third position the energizing circuit is established for the ringer relay 164. This circuit extends from ground G^{14} through the interrupter 165, relay 164, springs 171 and 170 and side switch wiper 150 to battery lead 100. Since this circuit includes interrupter 165, the relay 164 is energized only intermittently. Each time the relay 164 is energized it operates to disconnect the calling line from the called line and to bridge the generator M across the called line to ring the bell 175. When the called subscriber removes his receiver, or as soon thereafter as the relay 164 deenergizes, if it happens to be energized at the time, the called substation is provided with talking battery current from the central office. The circuit over which this talking current flows extends from ground G^{12} to side switch wiper 156, lower winding of relay 177, ringer relay springs 188 and 189, side switch wiper 187, shaft wiper 88, line 161, hook switch springs 186 and 185, primary winding of induction coil 184, transmitter 183, impulse springs 182, coils 181^a and 180^a of the coin-collecting device, line 160, springs 162 and 163, shaft wiper 86, ringer relay springs 181 and 180, private magnet springs 179 and 178, upper winding of back bridge relay 177 and side switch wiper 150 to battery lead 100. The current through the coils 181^a and 180^a of the coin-collecting device at the substation A' is in such direction at this time as to attract the armature toward the coil 181^a. When the connector back bridge relay 177 is energized by the talking current it operates to close the circuit through the relay 93. This circuit extends from ground G^{12} through side switch wiper 156, relay 93 and springs 288 and 289 to battery lead 100. The relay 93, upon energizing, operates to break the circuit of the ringer relay 164 at the springs 171 and 170, and to complete a locking circuit for itself through the springs 170 and 169 and side switch wiper 150. This locking circuit is independent of the springs 288 and 289 of the back bridge relay 177. Consequently, the relay 93 will not deënergize and close the circuit of the ringer relay 164 again in case the called subscriber should hang up his receiver and break the circuit of the back bridge relay 177 before the calling subscriber has hung up his receiver. When the relay 93 is energized it also operates to shift the springs 167 and 173 out of engagement with springs 168 and 174 and into contact with springs 166 and 172, respectively. By this operation the connections between the windings of the relay 92 and the trunk conductors 134 and 135 are interchanged. By this shifting of the connections of the relay 92 the current in the calling line is reversed. This reversal of the current causes the polarized relay of the coin-collecting devices at substation A to attract its armature in the opposite direction—that is, toward the coil 9. When the armature is attracted in this direction it carries the arm 7 to the left, forcing the springs 4,

5 and 6 into engagement, as was explained in connection with Figs. 4 and 5. The engagement of these springs 4, 5 and 6 short-circuits the transmitter 27 and shunts the secondary winding of the induction coil 28 with the resistance 190. The short-circuiting of the transmitter 27 makes it impossible for the calling subscriber to talk to the called subscriber through the medium thereof. The shunting of the secondary winding of the induction coil 28 does not prevent the calling subscriber from hearing the called subscriber answer, but does not allow him to converse through his receiver. When the calling subscriber hears the called subscriber answer he deposits a coin in the coin chute. This coin, in passing down the chute, releases the arm 7 from the arm 12, as has been previously explained, thereby allowing the springs 4, 5 and 6 to separate. The separation of these springs leaves the talking circuit for the calling substation in normal condition. Then the two subscribers may converse over the circuits represented by heavy lines in Figs. 1 and 2.

After the conversation is completed, the release of the central office apparatus is initiated by the hanging up of the receiver at the calling substation. When the receiver 25 is restored to the switch hook 26 the springs 95 and 96 are separated, thereby breaking the energizing circuit through the connector line relay 92. The relay 92, upon deënergizing, breaks the holding circuits of the release relays 139, 128 and 82 of the switches H, F and E, respectively. Although it has not been previously mentioned, it will be seen that when the side switch wiper 140 of the connector passes from second to third position the holding ground of the release relays 128 and 82 of the selector switches is transferred from ground G^{10} to ground G^{9} through the springs 138 and 137, so that the circuits of all of the release relays are controlled by the connector line relay. When the relay 139 of the connector deënergizes it completes a circuit from ground G^{9} through springs 137 and 146, springs 147 and 191, release magnet 192 and off-normal springs 193^{a} and 194 to battery lead 100. The energization of the magnet 192 immediately restores the mechanism of the connector to normal position, thereby breaking the connection at the called line and allowing the winding 157 of the switch C′ to deënergize. The deënergization of the release relays 128 and 82 of the selectors E and F closes the circuits of their respective release magnets. The energizing circuit for the release magnet 78 of the selector E extends from ground G^{3} through springs 110 and 112, springs 121 and 123, magnet 78 and off-normal springs 80 and 81 to battery lead 100. The circuit of the release magnet 193 of the selector F is similar to that just traced for the magnet 78. The energization of the magnets 78 and 193 restores the mechanism of their respective switches to normal position. When the shafts of the switches E, F and H reach their lowest positions, the energizing circuits of their respective release magnets are broken by the separation of the off-normal springs. The deënergization of the release relay 82 of the selector E also opens the holding circuit of the winding 44 in the line switch C, whereupon its plunger returns to normal position and all of the apparatus employed in the connection is left in readiness for another call.

The foregoing is an explanation of the manner in which connection is obtained with an idle line. It will now be explained how the calling subscriber is given the busy signal in case the called line is already in use when called by substation A. In the foregoing description it has been explained how, whenever a line is busy, either by having made a call or by having been called, there is a guarding ground potential on the connector private bank contacts of the said busy line. Thus if the wipers of the connector H are rotated onto the contacts of the busy line, a ground potential is extended from the private bank contact in that line through the private wiper 87, side switch wiper 156, which is then in second position, springs 195 and 196, relay 197 and to the spring 198^{a} of the private magnet relay 149. As the relay 149 deënergizes after the last impulse has been delivered to the rotary magnet of the connector, the spring 152 engages the spring 198^{a} before it breaks contact with the spring 151. The circuit of the private magnet 91 is therefore maintained by the current extending from the private bank contact of the busy line through the relay 197, causing the side switch to be locked in second position and the relay 197 to be energized. The energization of the relay 197 disconnects the rotary magnet 90 from the impulse spring 146, and shifts the holding ground of the relay 197 and the private magnet 91 from the guarded private bank contact to ground G^{10}, through the springs 196 and 198^{a}, springs 142 and 141, and side switch wiper 140 in second position. In its energized position the relay 197 also completes a circuit over which busy signaling current flows from the busy signaling machine L to the calling substation. This circuit extends from the battery lead 100 through the secondary winding of the induction coil 94^{a}, springs 199 and 200, contact point 201, side switch wiper 187, ringer relay springs 188 and 189, condenser 202, thence over the heavy conductors shown in Figs. 2 and 1 to and through the substation A and back

over the other side of the line to the upper winding of the connector line relay 92 to battery lead 100. Although the wipers of the connector H are standing on the contacts of the called line while a calling subscriber is thus receiving the busy signal, there is no connection between the two lines. The connection is open on one side of the line at the private magnet springs 178 and 179 and on the other side at the side switch wiper 187, which is locked in second position. The switches are released in this position by the hanging up of the receiver at the calling substation in practically the same manner as when an idle line is called. It will be noted that when a busy line is called the current in the calling line is not reversed. Therefore, the armature of the coin-collecting device at substation A is not attracted toward the coil 9 to close the springs 4, 5 and 6, but remains in the position shown in Fig. 1 until at some subsequent time an idle line is called from substation A and the call is answered.

From the foregoing it will be seen that the calling subscriber's telephone set is inoperative for talking after the called subscriber answers. The calling subscriber can listen and hear the response of the called subscriber, but cannot use his transmitter until after a coin or the like has been deposited in the slot at the calling substation. This is the only way in which the calling subscriber can talk to the called subscriber.

A further advantage of my improved system is as follows: 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 over which operators or exchange attendants are called, etc. In the system shown herein it is very easy to provide for free service when certain lines are called. This may be done by making the lines which are to be called free of charge accessible from special connector switches. These special connectors may be similar in all respects to the connector H, with the exception that the line relay 92 should be connected with the trunk conductors 134 and 135 direct instead of through the springs of the relay 93. In these special connectors the relay corresponding to the relay 93 would have no springs corresponding to the springs 166, 167, 168, 172, 173 and 174. Since the line relay of these connectors is connected directly to the line conductors, the current is not reversed in the calling line upon the removal of the receiver at a substation which has been called through one of the special connectors. Since the current in the calling line is not reversed, the calling telephone is not made inoperative for talking, and consequently the calling subscriber does not need to deposit a coin before he can talk.

What I claim as my invention is:—

1. In a telephone system, a calling and a called subscriber's line, means including automatic progressively movable switches controllable over two sides of a line in series for establishing connection between said lines, means for rendering the calling telephone inoperative for talking when the called subscriber answers, and means for thereafter rendering said telephone operative.

2. In a telephone system, a calling and a called subscriber's line, means including automatic progressively movable switches controllable over two sides of a line in series for establishing connection between two of said lines, means for reversing the current in the calling line when the called subscriber answers, means responsive to said reversal of current to render said telephone inoperative for talking, a measured service device, and means controlled by the operation thereof for thereafter rendering said telephone operative.

3. In a telephone system, a plurality of subscribers' lines divided into groups, means including automatic switches having motion of one character to select groups and a second motion to find a line in the selected group for establishing connection between two of said lines, means for controlling the two sides of a line in series to operate said switches, means for rendering said calling telephone inoperative for talking when the called party answers, and means for thereafter rendering said calling telephone operative.

4. In a telephone system, a plurality of subscribers' lines divided into groups, means including automatic switches having motion of one character to select groups and a second motion to find a line in the selected group for establishing connection between two of said lines, means for controlling the two sides of a line in series to operate said switches, means for reversing the current in the calling line when the called party answers, means responsive to said reversal of current to render the calling telephone inoperative for talking, a measured service device, and means controlled by the operation of said device for rendering said calling telephone operative.

5. In a telephone system, a calling and a called subscriber's line, means including automatic switches having motion in two intersecting planes for establishing a connection between two of said lines, means for controlling the operation of said switches over two sides of a line circuit in series, a transmitter and a receiver on each of said lines, and means controlled upon the re-

sponse of the called subscriber for closing a short-circuit directly around said transmitter on the calling line, said short-circuit excluding the calling receiver.

6. In a telephone system, a calling and a called subscriber's line, means including automatic switches having motion in two intersecting planes for establishing a connection between two of said lines, means for controlling the operation of said switches over two sides of a line circuit in series, a transmitter and a receiver on each of said lines, means controlled upon the response of the called subscriber for closing a short-circuit directly around said transmitter on the calling line, said short-circuit excluding the calling receiver, a measured service device, and means whereby the operation of said device opens said short-circuit.

7. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, and a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective.

8. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, and a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective.

9. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, magnet controlled means for removing the transmitter from service and for shunting the receiver to render it partly ineffective, and coin controlled means for restoring the device to full operative condition.

10. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, magnet controlled means for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective, and coin controlled means for restoring the device to full operative condition.

11. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective, and subscriber controlled means for restoring the device to full operative condition.

12. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective, and subscriber controlled means for restoring the device to full operative condition.

13. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective, and measured service means for restoring the device to full operative condition.

14. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective, and measured service means for restoring the device to full operative condition.

15. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective, and calling controlled means for restoring the device to full operative condition.

16. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective, and calling controlled means for restoring the device to full operative condition.

17. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, means for assessing a charge on the calling subscriber by rendering the calling

telephone inoperative for talking when the called party answers, means for rendering the said telephone operative, a third line and a station therefor, means for connecting the said first and third lines via said trunk free of charge, and means for signaling the called stations over their individual lines.

18. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, an automatic progressively movable switching apparatus for closing the connection via said trunk, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, means for rendering the said telephone operative, a third line and a station therefor, means for connecting the said first and third lines via said trunk free of charge.

19. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, means for rendering the said telephone operative, a third line and a station therefor, automatic progressively movable means for connecting the first and third lines via said trunk free of charge.

20. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, means operated by a coin or the like for rendering the said telephone operative, a third line and a station therefor, means for connecting the said first and third lines via said trunk free of charge, and means for signaling the called station over its individual line.

21. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, an automatic progressively movable switching apparatus for closing the connection via said trunk, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, means operated by a coin or the like for rendering the said telephone operative, a third line and a station therefor, automatic progressively movable means for connecting the first and third lines via said trunk free of charge.

22. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, means operated by a coin or the like for rendering the said telephone operative, a third line and a station therefor, automatic progressively movable means for connecting the first and third lines via said trunk free of charge.

23. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, a measured service device for rendering the said telephone operative, a third line and a station therefor, means for connecting the said first and third lines via said trunk free of charge, and means for signaling the called stations over their individual lines.

24. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, an automatic progressively movable switching apparatus for closing the connection via said trunk, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, a measured service device for rendering the said telephone operative, a third line and a station therefor, means for connecting the said first and third lines via said trunk free of charge.

25. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, a measured service device for rendering the said telephone operative, a third line and a station therefor, automatic progressively movable means for connecting the first and third lines via said trunk free of charge.

26. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, electrically operated means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, means for rendering the said telephone operative, a third line and a station therefor, means for connecting the said first and third lines via said trunk free of charge, and means for signaling the called stations over their individual lines.

27. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, an automatic progressively movable switching apparatus for closing the connection via said trunk, electrically operated means for assessing a charge on the calling subscriber by rendering the calling telephone

inoperative for talking when the called party answers, means for rendering the said telephone operative, a third line and a station therefor, means for connecting the said first and third lines via said trunk free of charge.

28. In a telephone system, a first line and a station therefor, a second line and a station therefor, a trunk line for connecting the two, electrically operated means for assessing a charge on the calling subscriber by rendering the calling telephone inoperative for talking when the called party answers, means for rendering the said telephone operative, a third line and a station therefor, automatic progressively movable means for connecting the first and third lines via said trunk free of charge.

29. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service while retaining the receiver in service, and automatic progressively movable central office switching apparatus for applying said battery to said line.

30. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative while retaining the receiver in service, and automatic progressively movable central office switching apparatus for applying said battery to said line.

31. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective, and automatic progressively movable central office switching apparatus for applying said battery to said line.

32. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective, and automatic progressively movable central office switching apparatus for applying said battery to said line.

33. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service while retaining the receiver in service, subscriber controlled means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

34. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative while retaining the receiver in service, subscriber controlled means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

35. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective, subscriber controlled means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

36. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly effective, subscriber controlled means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

37. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service while retaining the receiver in service, measured service means for restoring the device to full operative condition, and automatic progres-

sively movable central office switching apparatus for applying said battery to said line.

38. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative while retaining the receiver in service, measured service means for restoring the device to operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

39. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective, and measured service means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

40. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective, measured service means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

41. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service while retaining the receiver in service, calling controlled means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

42. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative while retaining the receiver in service, and calling controlled means for restoring the device to full operative condition.

43. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for removing the transmitter from service and for shunting the receiver to render it partly ineffective, calling controlled means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

44. In a telephone system, a central office, a substation telephone, a line connecting the telephone with the central office, a transmitter and battery in said line, a local receiver circuit at said telephone inductively associated with said line, a relay for short circuiting the transmitter to render it inoperative and for shunting the receiver to render it partly ineffective, calling controlled means for restoring the device to full operative condition, and automatic progressively movable central office switching apparatus for applying said battery to said line.

Signed by me at Chicago, Cook county, Illinois, this 15 day of July, 1910.

JOHN ERICKSON.

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