J. G. BLESSING.

TELEPHONE SYSTEM.

APPLICATION FILED OCT. 21, 1911.

1,075,007.

Patented Oct. 7, 1913.

2 SHEETS—SHEET 1.

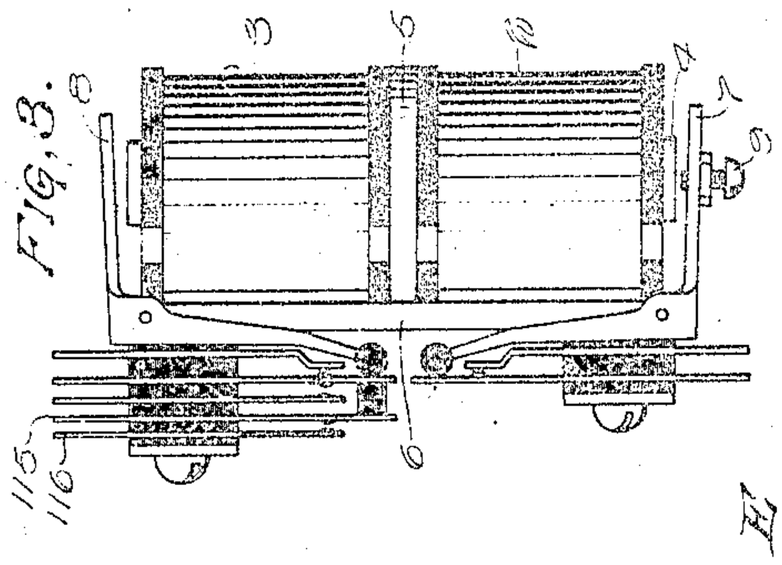

FIG. 3.

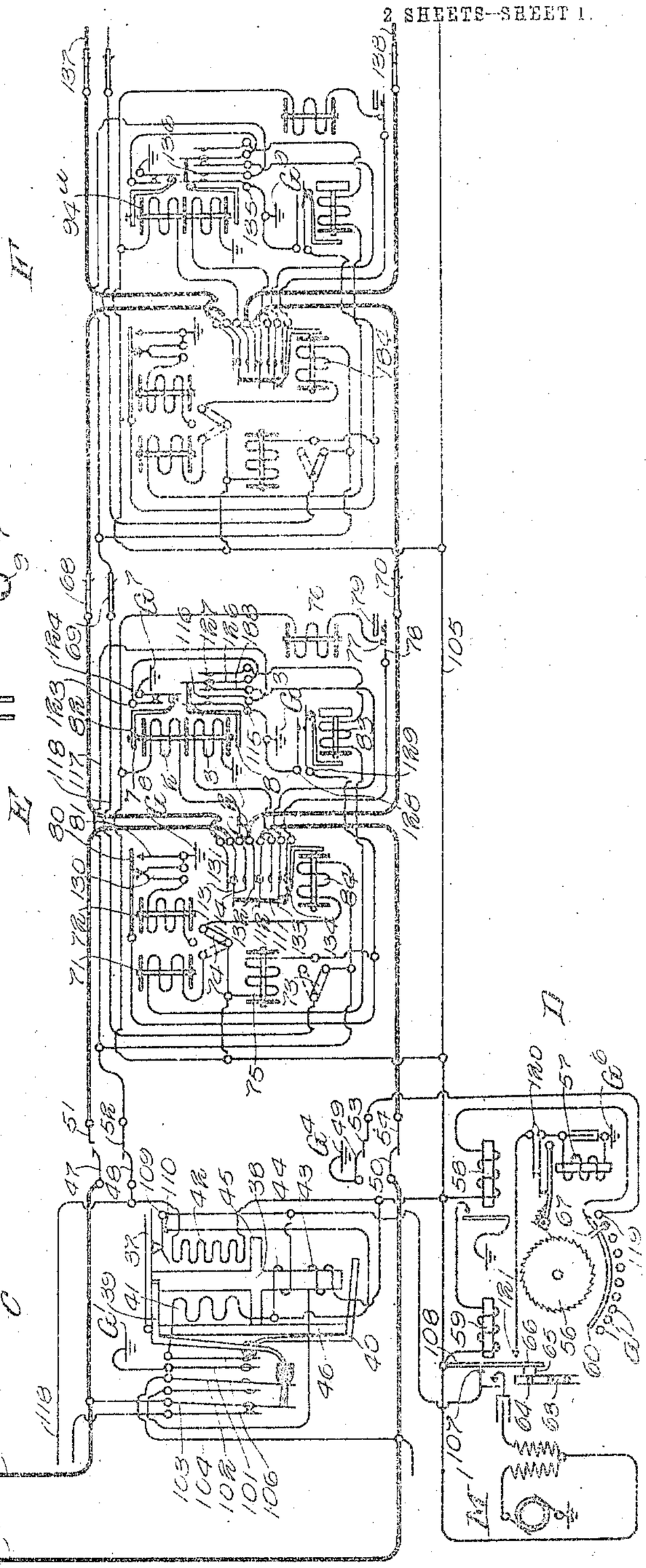

FIG. 1.

WITNESSES

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INVENTOR:

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2 SHEETS—SHEET 2.

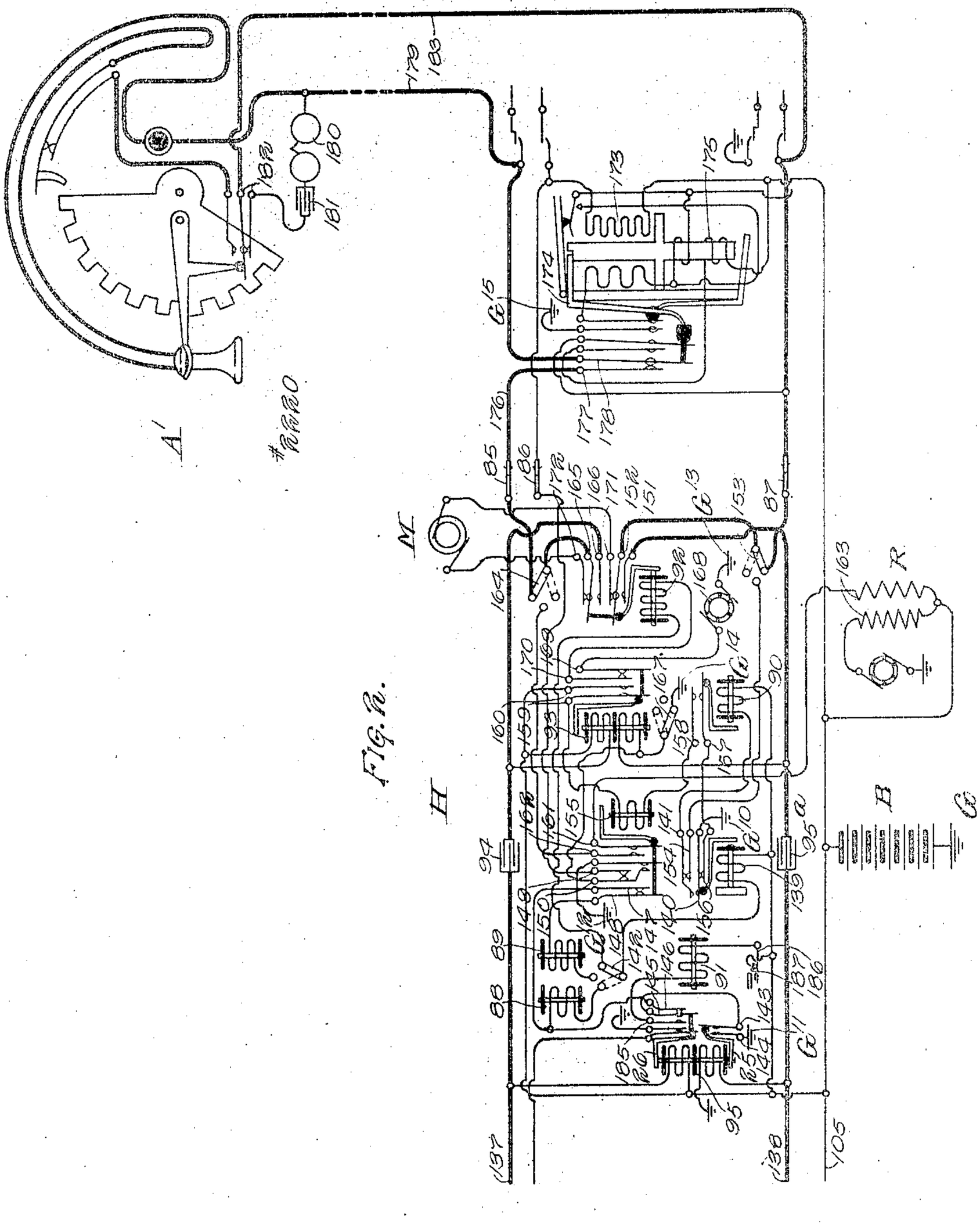

Fig. 2.

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UNITED STATES PATENT OFFICE.

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

TELEPHONE SYSTEM.

1,075,007. Specification of Letters Patent. Patented Oct. 7, 1913.

Application filed October 21, 1911. Serial No. 655,950.

To all whom it may concern:

Be it known that I, JOHN G. BLESSING, 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 Systems, of which the following is a specification.

My invention relates to telephone systems, and more particularly to automatic or semi-automatic telephone systems in which the automatic switches employed in establishing a connection between two subscribers' lines are controlled over two sides of a metallic line circuit in series. In such systems it is usual to employ one or more slow acting relays in the automatic switches in order to prevent the release of these switches during the transmission of the impulses for operating said switches.

My invention relates particularly to a combined quick and slow acting line relay for use in such selector and connector switches. This relay takes the place of the ordinary line relay, and also of the usual slow acting release relay, thus greatly simplifying the construction of these switches.

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

Figures 1 and 2 show diagrammatically a complete circuit connection between a calling telephone A and a called telephone A′ in a system in which my improved relay circuits are used. Fig. 3 is a view showing the construction of the relay.

The connection shown in Figs. 1 and 2 is represented as being established through the medium of an individual switch C, first selector E, second selector F and a connector switch H.

The automatic substation with which I have elected to illustrate my invention comprises the usual receiver 26, switch hook 27, transmitter 28, ringer 29 and condenser 30. Being an automatic substation it is provided with a pair of impulse springs 31 and 32 and an impulse wheel 33. The impulse wheel 33 carries on its periphery a number of impulse teeth 34 and is secured to a shaft 35, to which shaft there is also secured a dial (not shown) provided with finger holes. By means of the dial the impulse wheel may be rotated forward, after which it is returned to normal position by a spring (not shown). During this backward movement of the impulse wheel, each of the teeth 34 which passes the end of the spring 32 momentarily separates said spring from the spring 31. The number of teeth which are carried past the end of the spring 32 depends upon the digit called. If desired, the telephone illustrated in British patent to S. G. S. Dicker, No. 29,654 of 1910, may be substituted for the one shown in the drawings.

The line switch C, which is individual to the line of the substation A, and the master switch D are of the general type disclosed in British patent to R. W. James, No. 26,301 of 1906, but of the particular form shown in British patent to T. G. Martin, No. 1419 of 1910. As herein illustrated, the line switch C comprises the usual plunger (not shown) attached to the end of the plunger arm 37, which arm is controlled by the magnet 38. Besides the plunger arm 37, the magnet 38 also controls the relay armatures 39 and 40, and comprises four windings, namely, a pull-in winding 41, a cut-off winding 42, a line winding 43 and an auxiliary winding 44. The core of the magnet 38 is provided near its center with a lateral projection 45, to which latter the mounting 46 for the armatures 39 and 40 is attached. With this arrangement the magnetic circuit of the windings 41 and 42 is made separate from that of the windings 43 and 44, and therefore the armatures on one end of the magnet are not affected by the windings upon the other end. Of the two windings upon the upper end of the magnet, the winding 41 is the stronger and, when energized, operates both the plunger arm 37 and the armature 39. The winding 42, however, is not of sufficient strength to operate both armatures, but will operate the armature 39 from its normal position and will hold the plunger arm 37 in its operated position after it has once been attracted by the winding 41. When the plunger arm 37 is attracted, the plunger on the end thereof is forced into a group of springs, forcing the springs 47, 48, 49 and 50 into engagement with the springs 51, 52, 53 and 54, respectively. Although only one group of springs (47—54) is shown, each switch C is provided with a number of such groups of springs, each group forming a terminal of a trunk line leading to a selector E. Each of these trunk lines is com-

mon to a number of line switches C. The plungers of idle line switches normally engage a so-called plunger shaft, through the medium of which they are held opposite idle trunk lines by the master switch D, which latter is common to a group of line switches. As herein represented, the master switch D comprises, among other details, a ratchet wheel 56, motor magnet 57, relays 58 and 59 and a bank of contacts comprising a common segment 60 and an individual segment a' for each of the trunk lines to which the switch C has access. The ratchet wheel 56 is connected with the plunger shaft in such a manner that the rotary motion of said wheel imparts to the plunger shaft an oscillatory movement to move the idle plungers back and forth in front of the trunk terminals. Secured to the plunger shaft there is a locking plate 63 which is provided near its outer edge with a number of openings 64 which are adapted to be engaged by the pin 65 on the end of the armature 66 of the relay 59. The openings 64 are so spaced that the pin 65 can engage one of them only when the plungers which are in engagement with the plunger shaft are directly opposite the terminals of a trunk line. The wiper 67 always keeps the common segment 60 in electrical connection with the individual segment a' which corresponds to the trunk line in front of which the idle plungers are being held by the plunger shaft.

The first selector E is of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, being somewhat modified, however, in order to operate in a system in which the central office apparatus is controlled from the calling substation over the two sides of the line in series. The selector comprises the usual wipers 68, 69 and 70 carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 71 and a rotary motion controlled by the rotary magnet 72. The usual side switch comprising the wipers 73 and 74 is controlled by the private magnet 75 in a well-known manner. The usual release magnet 76 is normally disconnected from battery at the springs 77 and 78. As soon, however, as the switch shaft is raised from its lowest position, the arm 79 which is attached to said shaft permits the spring 78 to engage the spring 77. The mechanism of the selector E is released immediately upon the energization of the release magnet, rather than upon its deënergization as described in the said selector patent. The armature 80 of the rotary magnet has no finger for pressing down the armature of the private magnet 75, as shown in the said selector patent, but controls the said private magnet electrically through the medium of the contact point 81. The relay 82 deënergizes slowly after its energizing circuit has been broken. This slow action is usually obtained by securing a heavy copper ring around one end of the core of the magnet. The relay 84 controls means for closing a line through the selector E to the wipers 68 and 70. The wipers 68, 69 and 70 are adapted to engage a bank of contacts forming the terminals of trunk lines leading to selectors F. Each trunk line is common to a number of selectors E. The operations of the switch are controlled by the calling subscriber through the medium of the double-wound line relay 82. As shown in Fig. 3, the relay 82 comprises two coils 2 and 3 wound upon a core 4. The core 4 is provided at the center of its length with a flange 5 by means of which it is secured to the heel piece 6, upon the ends of which the armatures 7 and 8 are pivoted. Each armature controls a separate set of contact springs. The flange 5 being of magnetic material separates the magnetic circuits of the two coils, so that each armature is affected only by its own particular coil. The armature 7 is provided with a screw or rivet 9 of non-magnetic material which prevents the armature from coming into direct contact with the end of the core. With this arrangement the armature 7 will drop back immediately upon the breaking of the current in the coil 2. The armature 8 comes into direct contact with the end of the core, so that the residual magnetism holds it up for a short time after the circuit of the coil 3 is broken. Thus, if the circuit of the coils be made and broken in quick succession, the armature 7 will vibrate in synchronism with the impulses, while the armature 8 will remain continuously in its operated position. The same result may be obtained if, instead of the screw 9 in the armature 7, a cap or shield of non-magnetic material is placed over the end of the core of the magnet.

The selector F is like the selector E and no detailed description is, therefore, necessary.

The connector H (Fig. 2) is of the general type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but, like the selectors, is somewhat modified to operate in a two-wire system. Like the selectors, the connector comprises a set of wipers 85, 86 and 87 carried upon a shaft (not shown) which is controlled by the vertical magnet 88 and the rotary magnet 89. The usual side switch is controlled by the private magnet 90 in the usual manner. The release magnet 91 is similar to the release magnet 76 of the selector switch. The ringer relay 92 is provided for the purpose of connecting the ringer generator M with the called line after connection has been completed therewith. The talking battery current is fed to

the called substation through the winding of the so-called back-bridge relay 93. The talking circuit through the connector includes two condensers 94 and 95ª. The double-wound line relay 95 is similar to the line relay of the selector E, as shown in Fig. 3. The line switch C′ and substation A′ are similar in all respects to the line switch C and substation A (Fig. 1). The busy signaling machine shown at R is for the purpose of supplying busy signaling current to the line of the calling subscriber, in case the calling subscriber attempts to make connection with a line that is already in use.

At B a battery is shown with its positive terminal preferably grounded.

Having given a general description of the apparatus, I will now explain the operation by which one subscriber, subscriber A, for example, obtains connection with another subscriber, subscriber A′, for instance. The number of the substation A′ we will assume to be 2220. When the receiver is removed from the switch hook at the substation A, preparatory to making a call, the said hook rises, permitting the spring 96 to disengage the spring 97 and to engage the spring 98, thereby opening the circuit of the ringer 29. The engagement of the springs 96 and 98 places a bridge across the line conductors 99 and 100, which closes a circuit through the line winding 43 of the line switch C. The closure of this line circuit operates the line switch C in the usual manner to select an idle trunk extending to a selector switch E. As this line switch forms no part of my present invention, and as its operation is well-understood in the art, it is not thought necessary to describe its operation in detail. The calling subscriber now operates his calling dial in the usual manner for the first digit 2 of the called number. As the impulse wheel 33 returns to normal position after being rotated with the dial for the digit 2, the impulse springs 31 and 32 are momentarily separated twice. The separation of the impulse springs 31 and 32 breaks the energizing circuit of both windings of the selector line relay 82. As previously stated, the relay 82 is the same as the one shown in Fig. 3, and therefore the armature 7 acts quickly, thereby allowing the springs 123 and 124 to engage during the transmission of the impulses from the calling substation, while the armature 8 remains in its operated position to prevent the springs 126 and 115 from disengaging the springs 127 and 116, respectively, between impulses. During the transmission of said impulses, therefore, each time the armature 7 falls back a circuit is closed through the slow relay 83. This circuit extends from ground G^7 through the springs 124 and 123, springs 126 and 127, slow relay 83, vertical magnet 71 and side switch wiper 74 to the battery lead 105. The vertical magnet operates twice to step the shaft and shaft wipers 68, 69 and 70 to a point opposite the second level of bank contacts. The relay 83, which is included in the energizing circuit of the vertical magnet, is energized by the first impulse through it, but, being a slow acting relay, its circuit is not open long enough to permit it to deënergize until after the last impulse for the digit is delivered. In its operated position the relay 83 closes a circuit through the private magnet 75. This circuit extends from ground G^3 through the springs 128 and 129, private magnet 75 and then to the battery lead 105. After the last impulse for the first digit is delivered, the relay 83 deënergizes and opens the circuit of the private magnet 75, which in turn deënergizes and permits the side switch to pass to second position. In passing from first to second position, the side switch wiper 74 disconnects the battery from the vertical magnet and closes a circuit through the rotary magnet 72. This circuit extends from ground G^8 through the interrupter springs 130, rotary magnet 72 and side switch wiper 74 to the battery lead 105. The rotary magnet thereupon energizes to rotate the shaft and shaft wipers one step, to open its own circuit at the interrupter springs 130 and to close the circuit of the private magnet 75. The private magnet 75 thereupon energizes and remains in readiness to pass the side switch wipers to the third position, when its circuit is broken. When the circuit of the magnet 72 is broken at the springs 130, the armature 80 falls back, disconnecting the ground G^8 from the private magnet. If the first trunk upon the contacts of which the selector wipers have just been rotated is idle, the private magnet deënergizes, when the ground G^8 is disconnected and allows the side switch to pass to third position. If, however, the first trunk is already in use, the private wiper 69 finds the first contact which it engages grounded, as will be hereinafter more fully explained, and maintains the private magnet energized over the circuit extending from said grounded bank contact through the wiper 69, side switch wiper 73 and private magnet 75 to the battery lead 105. The private magnet thus locks the side switch in second position and the rotary magnet continues to operate in a manner similar to that of a buzzer to advance the wipers step by step until the private wiper 69 engages a non-grounded contact of an idle trunk, whereupon the private magnet deënergizes and permits the side switch to pass to third position.

The passage of the side switch from second to third position opens the operating circuit of the rotary magnet 72 and closes an energizing circuit through the line switching relay 84. This circuit extends

from ground G^3 through the springs 115 and 116, conductor 117, relay 84 and side switch wiper 74 to the battery lead 105. The relay 84 thereupon energizes to shift the springs 113 and 112 out of engagement with the springs 114 and 111 and into engagement with the springs 131 and 132, respectively, and also shifts the spring 133 out of engagement with the spring 134. The shifting of the springs 113 and 112 disconnects the line relay 82 from the line and extends the line from the calling substation through the wipers 68 and 70 to the selector F. After the relay 84 is energized, but before its circuit is broken by the falling back of the armature 8 of the relay 82, a new holding circuit is supplied to the relay 84 and the winding 42 of the line switch C. This circuit extends from ground G^9 through the springs 135 and 136, which were brought into engagement upon the energization of the relay 94^a, the circuit of the relay 94^a having been completed upon the energization of the relay 84 of the selector E, through the wiper 69, thence one branch extends through the winding 42, while another branch extends through the side switch wiper 73, relay 84 and side switch wiper 74 to the battery lead 105. The disengagement of the springs 133 and 134 by the relay 84 of the selector E opens the circuit of the release magnet 76, thus preventing its energization upon the deenergization of the relay 82.

When the calling subscriber operates his calling device for the second digit 2, the circuit of the line relay 94^a of the selector F is momentarily broken twice. The selector F operates in response to these impulses in exactly the same manner as explained for the selector E to extend the connection over the trunk lines 137 and 138 to the connector H, the line relay of which immediately energizes to place the usual holding and guarding ground on the switches F, E and C. When the calling subscriber operates the dial for the third digit 2 and the fourth digit 0, the connector switch H is operated to connect with the desired called subscriber's line. Ringing current is then automatically supplied to the called subscriber's line from the ringing generator M. The operation of this switch is well understood in the art, the relay 95 operating in a manner similar to the relay 82 of the selector switch E. In case the called subscriber's line is busy, a busy signal is transmitted back to the calling subscriber's line. This operation of the connector switch is well understood in the art, and it is accordingly thought unnecessary to describe the same further in detail. The connection between the calling and called subscribers' lines being now completed, they may carry on an uninterrupted conversation. The release of the central office mechanism is completed upon the hanging up of the receiver at the calling substation. The hanging up of this receiver breaks the energizing circuit of the connector line relay 95. The relay 95, upon deenergizing, permits its armature 26 to fall back, which disconnects the holding ground from the line switching relays 84 and 184 of the selectors E and F, respectively, and also disconnects the holding ground from the cut-off winding 42 of the line switch C. The deënergization of the relay 95 of the connector H also closes a circuit through the release magnet 91. This circuit extends from ground G^{11} through the springs 144 and 143, 145 and 185, release magnet 91 and off normal springs 186 and 187 to the battery lead 105. The release magnet thereupon energizes to release the mechanism of the connector H. Upon returning to normal position the shaft breaks the circuit of the release magnet at the springs 186 and 187. The deënergization of the line switching relays 84 and 184 of the selectors E and F, respectively, closes a circuit through their respective release magnets. This circuit in the selector E, for instance, extends from ground G^7 through the springs 124 and 123, 126 and 188, 133 and 134, off normal springs 78 and 77 and release magnet 76 to battery. The holding circuit for the winding 42 being broken allows the armature 39 and the plunger arm 37 of the line switch C to return to normal position, thus leaving all of the central office mechanism in readiness for another connection to be set up.

While I have described my invention in connection with a particular type of telephone system, it is to be understood that I do not wish to be limited to such use, as it is obvious that my improved quick and slow acting relay may be used in connection with other types of systems, and may be used in any connection in which a quick and slow acting relay would be useful and desirable.

What I claim as my invention is:—

1. In a telephone system, an automatic switch having motion in one plane to select groups and motion in an intersecting plane to find a line in a selected group, and means including a relay for controlling the operation of said switch, said relay having a pair of armatures, the operation of one of said armatures being sluggish as compared with the operation of the other of said armatures.

2. In a telephone system, an automatic switch, means including a relay for controlling the operation of said switch, a plurality of armatures for said relay, and means for preventing one of said armatures from coming in contact with the magnet of said relay, whereby said armature is quick acting as compared with the other of said armatures.

3. In a telephone system, an automatic

switch, means including a relay for controlling the operation of said switch, a plurality of energizing windings for said relay, means for energizing said windings over a line circuit in series, a plurality of armatures for said relay, means for rapidly interrupting said line circuit, means whereby one of said armatures responds to said interruptions, and means for maintaining the other of said armatures in attracted position during the transmission of said impulses.

4. In a telephone system, an automatic switch, means including a relay for controlling the operation of said switch, said relay having a plurality of armatures, independent magnetic circuits for said armatures, means for transmitting a series of impulses, means whereby one of said armatures vibrates in synchronism with said impulses, and means for maintaining the other of said armatures in operated position during the transmission of said impulses.

5. In a telephone system, an automatic switch, means including a relay for controlling the operation of said switch, a plurality of energizing windings for said relay, a plurality of armatures controlled by said relay, said armatures having independent magnetic circuits, means for transmitting a series of impulses through said energizing windings, means whereby one of said armatures vibrates in synchronism with said impulses, and means for maintaining the other of said armatures energized during the transmission of said impulses.

6. In a telephone system, lines divided into groups, an automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, and means including a relay for controlling the operation of said switch, said relay having a pair of armatures, the operation of one of said armatures being sluggish as compared with the operation of the other of said armatures.

7. In a telephone system, lines divided into groups, an automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a relay for controlling the operation of said switch, a plurality of armatures for said relay, and means for preventing one of said armatures from coming in contact with the magnet of said relay, whereby said armature is quick acting as compared with the other of said armatures.

8. In a telephone system, lines divided into groups, an automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a relay for controlling the operation of said switch, a plurality of energizing windings for said relay, means for energizing said windings over a line circuit in series, a plurality of armatures for said relay, means for rapidly interrupting said line circuit, means whereby one of said armatures responds to said interruptions, and means for maintaining the other of said armatures in attracted position during the transmission of said impulses.

9. In a telephone system, lines divided into groups, an automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a relay for controlling the operation of said switch, said relay having a plurality of armatures, independent magnetic circuits for said armatures, means for transmitting a series of impulses, means whereby one of said armatures vibrates in synchronism with said impulses, and means for maintaining the other of said armatures in operated position during the transmission of said impulses.

10. In a telephone system, lines divided into groups, an automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a relay for controlling the operation of said switch, a plurality of energizing windings for said relay, a plurality of armatures controlled by said relay, said armatures having independent magnetic circuits, means for transmitting a series of impulses through said energizing windings, means whereby one of said armatures vibrates in synchronism with said impulses, and means for maintaining the other of said armatures energized during the transmission of said impulses.

11. In a telephone system, a relay, an energizing circuit therefor, a plurality of magnetic circuits, a single armature in each magnetic circuit controlled by a magnetic force therein, and means for varying the current in said energizing circuit, said current and magnetic forces being so related and of such character that the variations in the current cause an operation of one of the armatures only.

Signed by me at Chicago, Cook county, Illinois, this 18th day of October, 1911.

JOHN G. BLESSING.

Witnesses:

ARTHUR J. RAY,

E. D. FALES.