M. SETTER.

TELEPHONE AUTOMATIC TRUNK SELECTING SYSTEM.

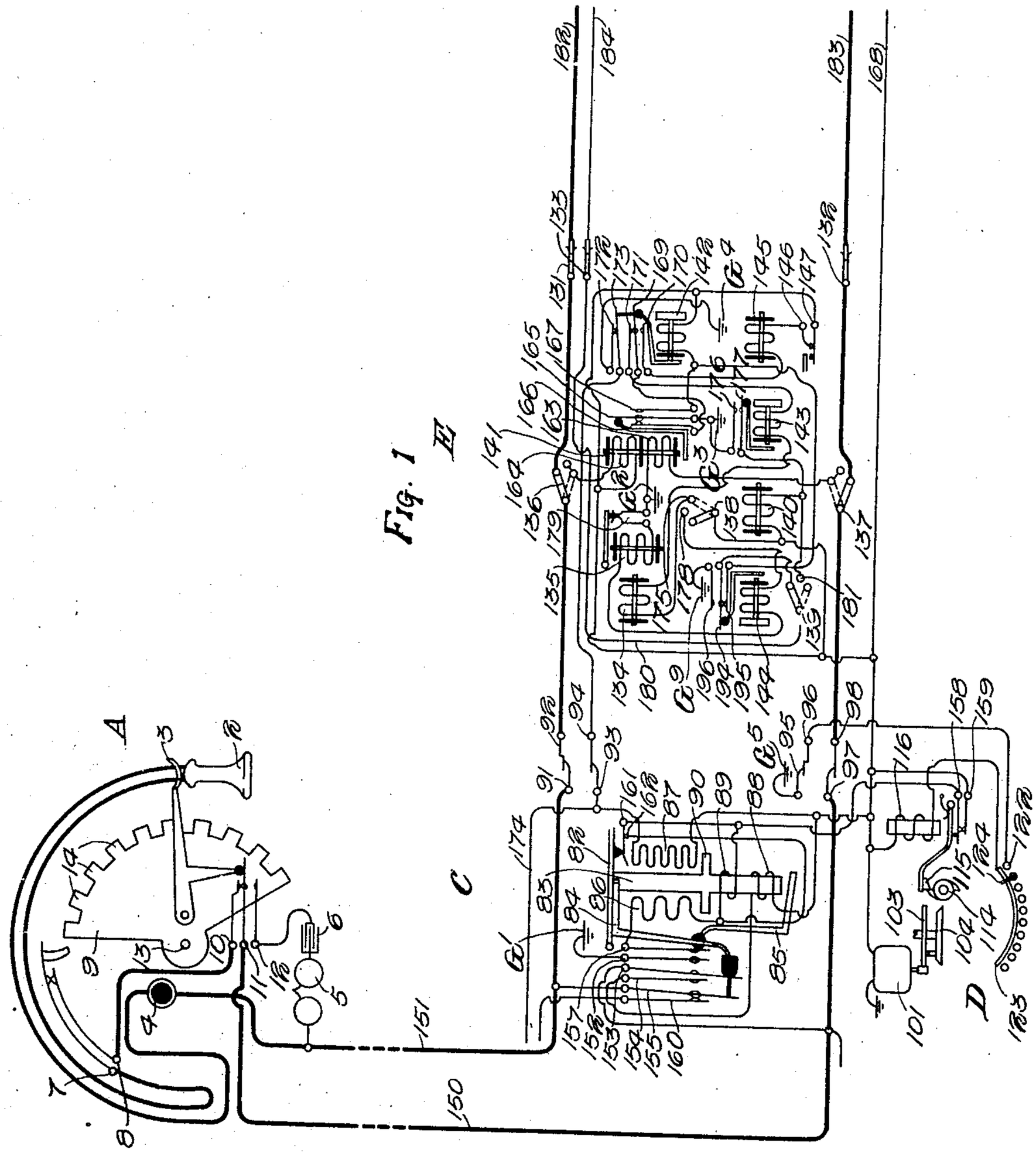
APPLICATION FILED MAY 6, 1910.

1,104,451.

Patented July 21, 1914.

4 SHEETS—SHEET 1.

Fig. 1



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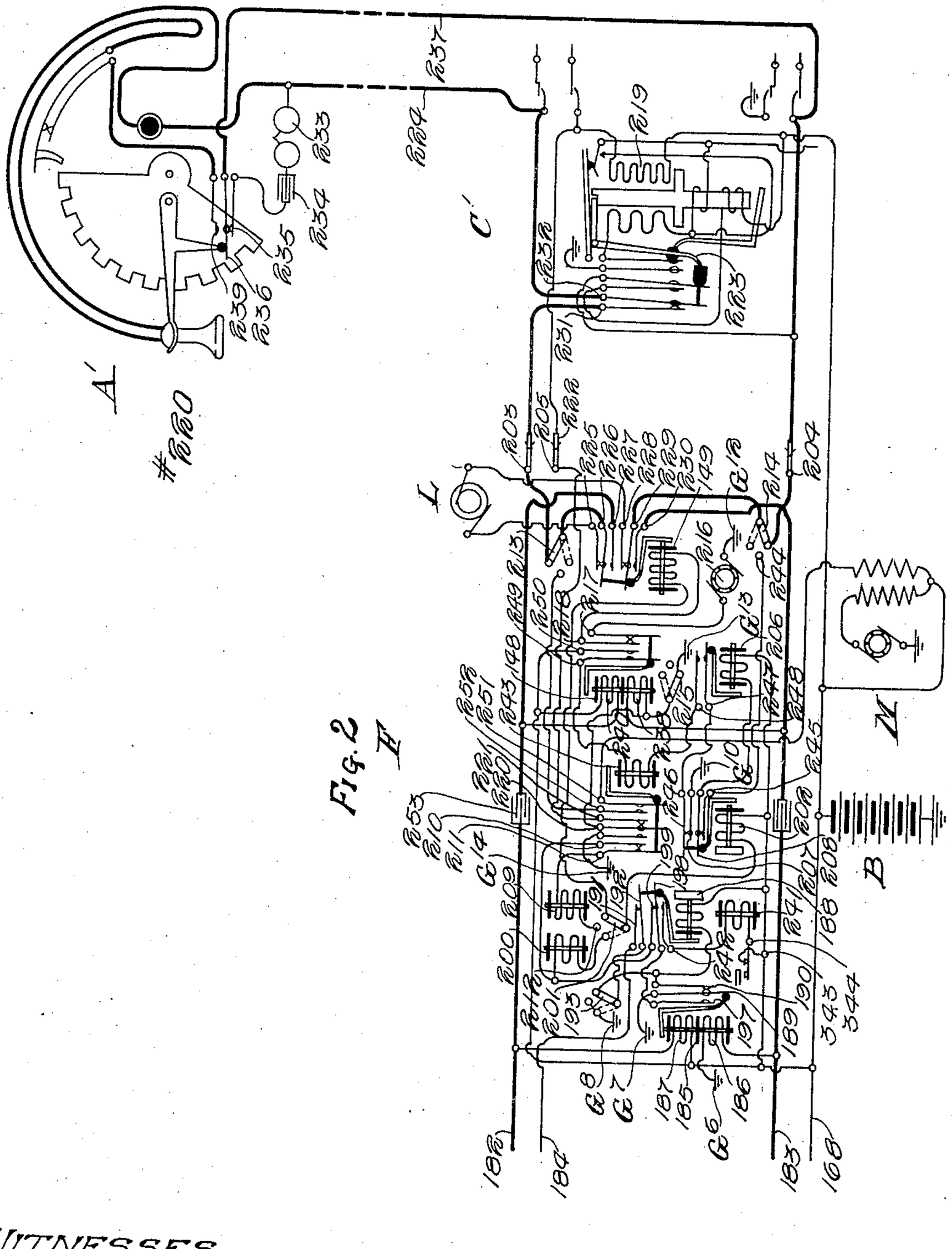

FIG. 2

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4 SHEETS—SHEET 3.

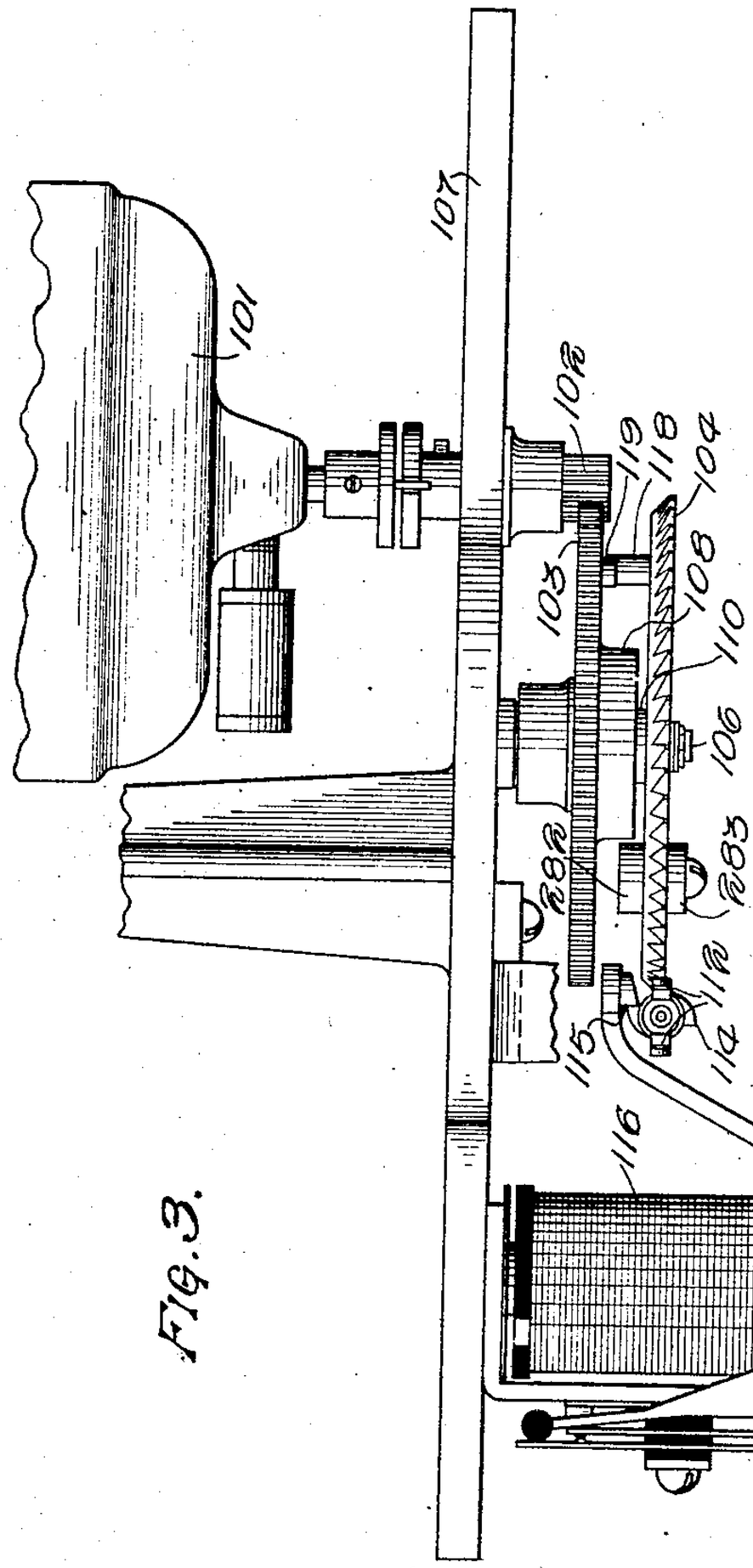

FIG. 3.

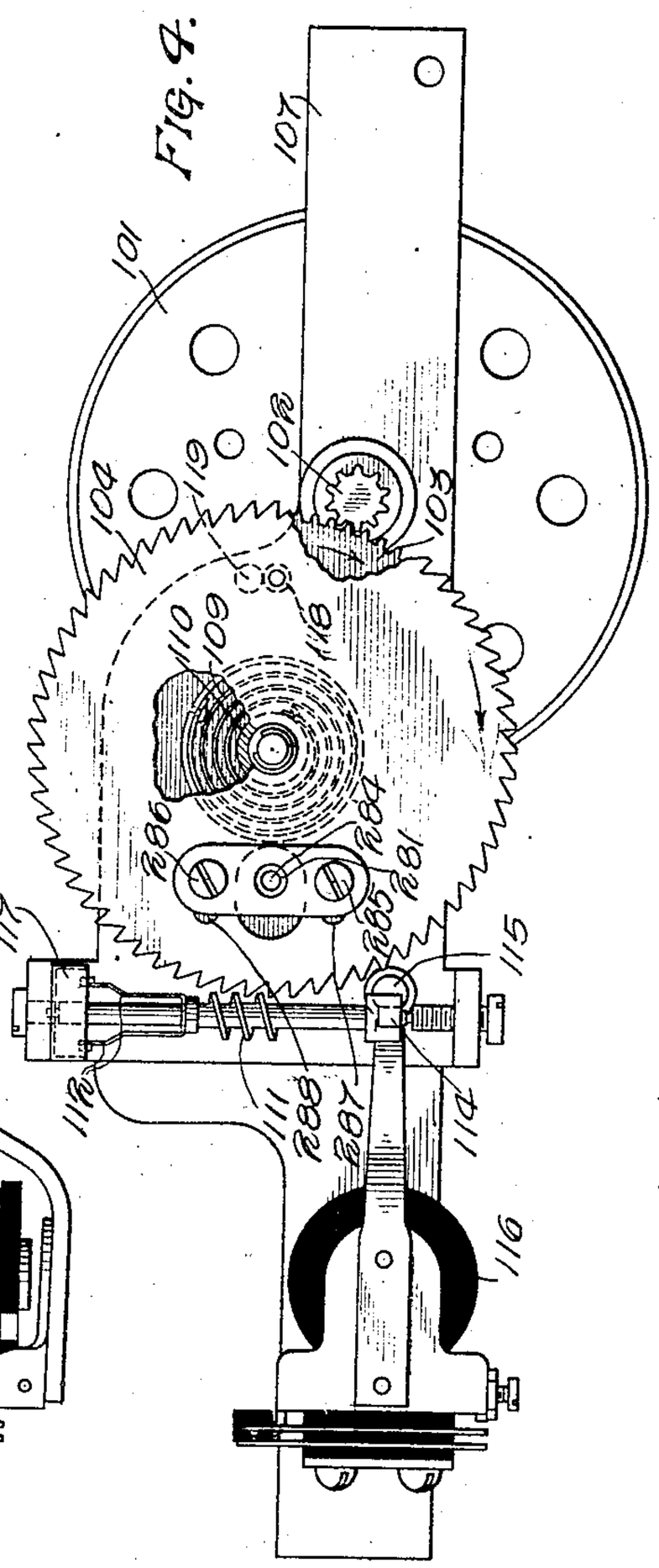

FIG. 4.

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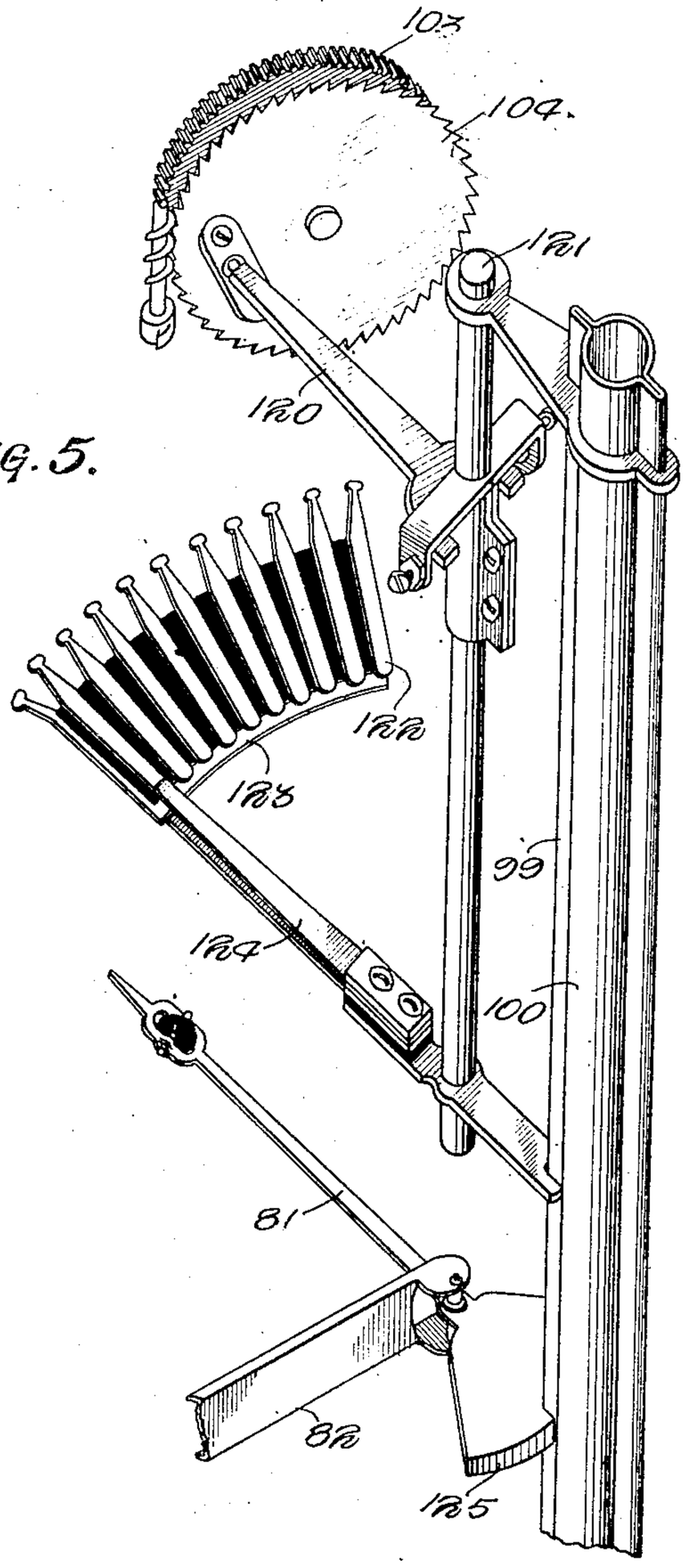
4 SHEETS—SHEET 4.

FIG. 5.



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UNITED STATES PATENT OFFICE.

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TELEPHONE AUTOMATIC TRUNK-SELECTING SYSTEM.

1,104,451. Specification of Letters Patent. **Patented July 21, 1914.**

Application filed May 6, 1910. Serial No. 559,826.

To all whom it may concern:

Be it known that I, MICHAEL SETTER, 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 Automatic Trunk-Selecting Systems, of which the following is a specification.

My invention relates to telephone exchange systems in which means are provided for automatically selecting idle trunks in response to a calling subscriber, or a calling operator, depending upon whether the system is entirely automatic or semi-automatic in character.

As hereinafter described, my invention contemplates an automatic switch of such character that it will automatically select idle trunks by a continuous movement of the wipers thereof from one trunk terminal to another, as distinguished from the step-by-step movement heretofore employed for this purpose, and in which the said continuous motion is supplied by suitable motive power, preferably an electric motor, as will hereinafter more fully appear.

To the foregoing and other useful ends my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings Figures 1 and 2 show a complete circuit connection between a calling substation A and a called substation A′ in a system embodying the principles of my invention. Figs. 3 and 4 are a top and front view, respectively, of my improved master switch. Fig. 5 is a view representing the manner in which the master switch is connected to the plunger shaft which it controls.

In Fig. 1 there is shown an automatic substation the line conductors of which are connected to an individual switch C at the central office. A group of these individual switches C is controlled by one of my improved master switches represented diagrammatically at D. Each group of switches C has access to a plurality of trunk lines, each of which terminates in a selector switch E. A group of selector switches E has common access to a number of trunk lines, each of which terminates in a connector switch F (Fig. 2). The connector F, together with a number of other similar switches, has access to a group of substations of which the substation A′ is a member. At the central office there is allotted to the substation A′ an individual switch C′ similar to the switch C (Fig. 1). At L there is shown a ringing current generator, and at M a busy signaling machine is shown. At B there is shown a battery, having one pole grounded, which supplies current for operating the central office apparatus and for furnishing talking current.

The automatic substations A and A′ may be of any suitable or approved type. As illustrated at A the substation with which I have elected to illustrate my invention comprises a receiver 2, switch hook 3, transmitter 4, ringer 5, condenser 6, impulse springs 7 and 8 and impulse wheel 9. The switch hook 3 controls the substation circuits through the medium of springs 10, 11 and 12. The impulse wheel 9 carries upon its periphery a number of impulse teeth 14 and is secured to the shaft 13, to which latter there is also secured a dial (not shown) provided with finger holes. In order to make a call the receiver is removed from the switch hook, a finger is inserted in the opening of the dial corresponding to the first digit of the desired number, the dial is rotated until the finger strikes a stop and is then allowed to be returned to normal position by a spring (not shown). This operation of the dial is repeated in succession for each digit. As the dial is rotated forward, a number of impulse teeth 14, corresponding to the digit to be called, are advanced past the end of the impulse spring 7. The impulse teeth 14 are so arranged that during the forward rotation of the dial the springs 7 and 8 are not separated, but each tooth that passes the end of the spring 7 during the backward rotation of the impulse wheel momentarily forces the spring 7 out of engagement with the spring 8.

The subscriber's individual switch C (Fig.

1) is of the general type disclosed in British Patent No. 26,301 of 1906, but is of a slightly modified construction. The line switch O is provided with a plunger which is not shown in Fig. 1, but is represented at 81 in Fig. 5. The plunger 81 is attached to a plunger arm 82 (Fig. 1) which is under the control of the magnet 83. The magnet 83 also controls two relay armatures 84 and 85. This magnet comprises four windings 86, 87, 88 and 89 designated, respectively, as a pull-down winding, a bridge-cut-off winding, a line winding and an auxiliary winding. The collar 90, which is a part of the core of the magnet 83, is secured to the bracket to which the armatures 82, 84 and 85 are pivoted, and thus the magnetic circuit of the windings 86 and 87 is separate and distinct from that of the windings 88 and 89. The energization of the windings 86 and 87 affects only the armatures 82 and 84, while the armature 85 is attracted only by the energization of the windings 88 and 89. The energization of the winding 86 upon the upper end of the magnet serves to attract both the plunger arm 82 and the armature 84. The magnetic effect of the winding 87 is much weaker than that of the winding 86, and since the plunger arm 82 is normally separated from the core of the magnet 83 by a greater distance than the armature 84, and is held in this position by a stronger spring, the energization of the winding 87 alone operates only the armature 84. If, however, the winding 87 is energized while the plunger arm 82 is in its operated position, it will be held in this position by the winding 87 after the circuit of the winding 86 is broken. When the plunger arm 82 is attracted by the magnet 83, the plunger on the end of this arm is driven into a group of contact springs 91, 92, 93, 94, 95, 96, 97 and 98 to force them into contact in pairs, as indicated in the drawings. Although only one group of springs (91—98) is shown, each switch C is provided with a number of such groups, each group forming the terminal of a trunk line which terminates in a selector switch E. Each one of these trunk lines is connected to the corresponding contact springs of a number of switches C. These groups of contact springs of each switch are arranged upon a circular arc just in front of the point of the plunger 81. The other end of this plunger is provided with a fan-like projection, in the center of which there is a notch which is adapted to register with a flange 99 upon a so-called plunger shaft 100 (Fig. 5) when the plunger is in its normal or retracted position. The plunger shaft is controlled by a so-called master switch D and is always held thereby in such a position that the plungers which are in locking engagement with the said shaft are in front of the terminal of a trunk line which is not already in use by some other switch.

The master switch D is shown diagrammatically in Fig. 1, but more fully in Figs. 3, 4 and 5. Referring to Figs. 3, 4 and 5, the construction of the master switch is as follows: In Figs. 3 and 4, 101 represents an ordinary small electric motor. The shaft of this motor is detachably connected to a pinion 102 which meshes with a gear wheel 103. This gear wheel 103, together with a toothed wheel 104, is rotatably mounted upon a shaft 106 which projects from the frame 107. On the face of the wheel 103 there is a cup 108 in which is placed a flat coiled spring 109. The outer end of the spring 109 is secured to the inside of the cup 108, while the other end of the spring is secured to the hub 110 of the wheel 104 which extends inside the cup 108. With this arrangement it is evident that when the wheel 103 is rotated in a clock-wise direction by the motor 101, the wheel 104 will tend to turn in the same direction, but if the wheel 104 is held stationary by any means, the rotation of the wheel 103 stores up tension in the spring 109 until the motor is stopped. The teeth of the wheel 104 register with a worm gear 111, to one end of which is secured a pair of governor springs 112, while the other end is provided with a locking member 114. The locking member 114 normally engages the lug 115 upon the end of the armature of relay 116, whereby the worm gear 111, and consequently the wheel 104, is effectively locked against rotation. When the relay 116 is energized the lug 115 disengages the locking member 114, which allows the wheel 104 to be rotated until the relay 116 again becomes deënergized. The speed of rotation of the wheel 104 is governed by the governor springs 112. When the speed becomes too great the weights on the ends of the springs 112 move outward and rub on the sides of stationary cup 117, thus by their friction retarding the movement of the gear 111 and wheel 104. From the back of the wheel 104 a pin 118 projects into the path of a pin 119 which projects from the front of the wheel 103. When the wheel 104 is locked, as has been explained, the motor 101 rotates the wheel 103 until the pin 119 strikes the pin 118, when the motor and wheel 103 are stopped also. Referring now particularly to Fig. 5, the wheel 104 is connected with the plunger shaft 100 through the medium of the link 120 in such a manner that the rotary motion of the wheel 104 causes the shaft 100 to oscillate back and forth about the shaft 121 as an axis. This oscillation of the plunger shaft 100 causes the point of the plunger 81 to be moved back and forth in front of its trunk terminal springs. The connection be-

tween the link 120 and wheel 104 consists of a ball and socket joint. This joint comprises a small ball 281 (Fig. 4) which is loosely held in a spherical cavity in the two plates 282 and 283 (Fig. 3). Half of this cavity is formed in each plate. The hemispherical cavity in each plate is formed in a projection that extends partly through an opening in the wheel 104. These projections meet when the plates 283 and 282 are clamped in place, so that the ball 281 is completely inclosed except at the top, where an opening is cut through the face of the plate 283 to permit the end of the link 120 to project into the opening 284 in the ball 281. The plates 282 and 283 are clamped to the wheel 104 by screws 285 and 286 which pass through openings in the plate 283 and wheel 104 into threaded holes in plate 282. The openings 287 and 288 in the wheel 104 are made in the form of slots in order that the plates 282 and 283 may be moved toward or away from the center of the wheel, so as to adjust the length of stroke of the plunger shaft 100. The master switch is also provided with a bank or group of contacts, which group comprises an individual segment 122 for each trunk to which the switch C has access and one common segment 123. The wiper 124 is adapted to always keep the individual contact which corresponds to the trunk line before which the idle plungers are resting in electrical connection with the common segment.

Briefly, the operation of the master switch D is as follows: The motor 101 is permanently connected to battery and is thus always energized, keeping the spring 109 under tension. When a subscriber's individual switch operates, its plunger disengages the plunger shaft and enters the group of contact springs before which it is being held by the plunger shaft 100. When the plunger thus operates, the relay 116 is energized, its circuit including the wiper 124 and the individual segment upon which it is resting. As soon as the relay 116 is energized the locking member 114 is released, allowing the wheel 104 to be rotated forward by the spring 109. As soon as the wheel 104 has moved far enough to rotate the wiper 124 off the contact which corresponds to the trunk line which was seized by the switch which just operated, the relay 116 deënergizes and instantly locks the wheel 104 again. This forward movement of the wheel 104 and plunger shaft 100 moves the idle plungers which are engaged with the shaft away from the terminal of the busy trunk to an idle one. Of course, as soon as the wheel 104 is moved, as just explained, the pin 118 leaves the pin 119, whereupon the motor 101 moves the wheel 103 forward to restore the tension to the spring 109. As soon as the pin 119 catches up with the pin 118 the motor again stops. The reason that a spring is used to move the plunger shaft, rather than allowing the motor to do so directly, is that the spring responds much more quickly than the motor when the mechanism is unlocked.

The selector switch E is of the well-known type disclosed in United States Letters Patent #815,321, granted March 13, 1906, to Keith, Erickson and Erickson. As herein represented, however, the circuits of the selector E are somewhat modified to enable it to be operated in a system in which the switches are controlled over the two sides of the line in series. Among other details, the selector E comprises a set of wipers 131, 132 and 133 which are carried upon a shaft having a vertical movement controlled by the vertical magnet 134, and a rotary motion under control of the rotary magnet 135. The side switch, comprising the wipers 136, 137, 138 and 139, is controlled by the so-called private magnet 140 in a well-known manner. The usual vertical and rotary line relays are here combined in one double-wound relay 141. The relays 142, 143 and 144 are relays that deënergize slowly after their circuits have been broken. This slow action is usually accomplished by placing a heavy ring of copper around one end of the magnet core. Means for releasing the switch are provided in the release magnet 145, which is always disconnected from the battery except when the shaft is raised one or more steps, thereby allowing the spring 146 to engage spring 147. 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 selector is also provided with a group or bank of contacts which are adapted to be engaged by the wipers 131, 132 and 133 and which form terminals of trunk lines leading to connector F (Fig. 2).

The connector F is of the general type disclosed in United States Letters Patent #815,176, granted March 13, 1906, to Keith, Erickson and Erickson, and its mechanical features are very similar to those of the selector E. The connector F is provided with a so-called back-bridge relay 148 through the windings of which the called substation is provided with talking battery current. A ringer relay 149 is provided for the purpose of controlling the application of signaling current to the called line.

Having given a description of the apparatus, I will now give a detailed description of the various operations performed in the process of establishing a connection between two lines. It will be assumed that the subscriber at substation A desires to communicate with the substation A′, the number of which will be taken to be 220. The first act

to be performed in making a call is to remove the receiver from the switch hook. When the receiver is removed the hook 3 rises, allowing spring 11 to disengage spring 12 and engage spring 10. The disengagement of the springs 11 and 12 opens the circuit through the ringer 5, and the engagement of the springs 10 and 11 closes a bridge across the line conductors 150 and 151, which bridge includes the transmitter 4, impulse springs 7 and 8 and the winding of the receiver 2. The closure of this bridge across the line completes an energizing circuit through the line winding 88 of the switch C. This circuit extends from ground G′ through springs 152 and 153, thence over line conductor 150 through the springs 11 and 10, impulse springs 8 and 7, receiver 2, transmitter 4, thence back over line 151 and through springs 155 and 154, winding 88 to the battery lead 168, thence through the battery B to ground G. The winding 88, upon being energized, attracts the armature 85, which forces the spring 157 into engagement with spring 152, thereby closing a circuit through the pull-down winding 86. This circuit extends from ground G′ through the springs 152 and 157, and through windings 86 and 89 and springs 158 and 159 to the battery lead 168, thence through the battery B to ground G. The winding 86, upon energizing, attracts the plunger arm 82 and cut-off armature 84, as has been previously explained. The armature 84 operates to press springs 153 and 155 away from springs 152 and 154, respectively, and to force spring 155 into contact with spring 160. The engagement of springs 155 and 160 has no particular utility at this time. The disengagement of springs 153 and 155 from the springs 152 and 154 disconnects the winding 88 and ground G′ from the line conductors. The armature 85 does not fall back immediately upon the breaking of the circuit of the winding 88, but remains held up for an instant by the current flowing through the winding 89 in series with the winding 86. When the plunger arm 82 is operated by the magnet 83 it not only forces the springs 91 and 92, etc. into contact, as previously explained, but forces the spring 161 into contact with the contact point 162. The engagement of springs 161 and 162 short-circuits the auxiliary winding 89, which allows the armature 85 to return to normal position to break the circuit through the pull-down winding 86. Before this circuit is broken, however, the circuit of winding 87 is closed as follows: At the instant the springs 91 and 97 are forced into contact with the springs 92 and 98 by the plunger of the switch C, a circuit is closed through the line relay 141 of the selector E. This circuit extends from ground G^2 through the winding 163 of relay 141, through side switch wiper 137, contact springs 98 and 97, line 150, thence through the substation A and back over line 151, through springs 91 and 92, side switch wiper 136 and winding 164 of relay 141 to the battery lead 168. The relay 141, upon energizing, operates to shift the spring 165 out of engagement with spring 166 and into contact with spring 167, thereby closing a circuit through the relay 142. This circuit extends from ground G^3 through the springs 165 and 167 and through the relay 142 to the battery lead 168. The relay 142, upon energizing, shifts the spring 169 out of engagement with the spring 170 and into contact with the spring 171, and closes contact between the springs 172 and 173. The engagement of the springs 172 and 173 closes a circuit extending from ground G^4 through springs 172 and 173, springs 94 and 93, and through the winding 87 of the switch C to battery lead 168. This current through the winding 87 maintains the arm 82 and armature 84 in an operated position, as has been previously stated. The engagement of springs 172 and 173 at the selector E extends a guarding potential from the ground G^4 to the conductor 174, and thence to the private bank contact corresponding to the line of substation A in the bank of all the connector switches which have access to that line. This guarding potential prevents the line from being seized for connection while it is in use.

At the instant that the springs 95 and 96 are forced into contact by the plunger of the switch C, the relay 116 of the master switch D is energized over a circuit extending from ground G^5 through the springs 95 and 96, contact point 122, wiper 124, segment 123 and relay 116 to battery lead 168. The relay 116, upon energizing, unlocks the wheel 104, allowing it to rotate to move the plungers of the idle switches away from the terminal of the trunk line which has just been seized. As soon as the wiper 124 leaves the contact 122, the relay 116 deënergizes and again locks the wheel 104, with the idle plungers resting in front of the terminal of the next trunk. If this next trunk is busy, however, the wiper 124 will find the corresponding contact grounded, the relay 116 will remain energized and the plungers will be advanced past the busy trunk or trunks to an idle one. It will be noted that as long as the relay 116 is energized, and, consequently, as long as the master switch is operating, the springs 158 and 159 are separated, thus disconnecting the winding 88 of all the switches C which are controlled by the master switch D from the battery lead 168. This prevents the possibility of any subscriber's switch being operated while its plunger is being moved from one trunk to another.

The foregoing are the operations which

follow immediately upon the removal of the receiver from the hook, and before the calling device is operated. Now, when the calling device is operated for the first digit 2 the impulse springs 7 and 8 are separated twice momentarily. Each time these springs are separated, the relay 141 at the selector E is deënergized to permit the spring 165 to disengage spring 167 and engage spring 166. Since the disengagement of springs 165 and 167 is only momentary, the slow-acting relay 142 does not have time to deënergize and, consequently, the engagement of springs 165 and 166 closes an energizing circuit through the vertical magnet 134. This circuit extends from ground G^3 through springs 165 and 166, springs 169 and 171, private magnet relay 143, vertical magnet 134, contact point 175 and side switch wiper 138 to battery lead 168. Since the digit called is 2 the vertical magnet receives two impulses, operating to raise the switch shaft two steps to carry the wipers 131, 132 and 133 two steps to a point opposite the second row of bank contacts. The private magnet relay 143, which is included in the circuit with the vertical magnet 134, is energized by the first impulse, but being a slow-acting relay does not have time to deënergize between impulses. When the relay 143 energizes it operates to close a circuit through the private magnet 140. This circuit extends from ground G^3 through springs 176 and 177 and magnet 140 to the battery lead 168. Shortly after the last impulse is delivered to the vertical magnet the relay 143 deënergizes to break the circuit of the private magnet 140. The magnet 140 thereupon deënergizes and allows the side switch to pass from first to second position. The side switch wiper 138, by passing from contact 175 to contact 178, disconnects the battery from the vertical magnet 134 and closes a circuit through the rotary magnet 135. This circuit extends from ground G^2 through interrupter springs 179, rotary magnet 135, relay 144, contact point 178 and side switch wiper 138 to the battery lead 168. The rotary magnet, upon energizing, attracts its armature, which rotates the wipers 131, 132 and 133 one step, presses down the armature of the private magnet 140, and breaks the circuit of its own magnet by separating the interrupter springs 179. When the circuit of the rotary magnet is thus broken its armature falls back, and, if the trunk line upon the terminals of which the selector wipers are rotated by the first step is not already in use, the armature of the private magnet falls back also, permitting the side switch to pass to third position to extend the line connection to the trunk line. If, however, the first trunk line is busy, the contact which is engaged by the private wiper 133 is provided with a guarding ground potential, as will be explained later. When the wiper 133 thus engages a grounded contact a circuit is completed extending from this contact over conductor 180, through side switch wiper 139, contact point 181, (the side switch being in second position), thence through the private magnet 140 to the battery lead 168. The private magnet thereupon locks the side switch in second position, whereby the circuit of the rotary magnet 135 is again closed as soon as its armature returns far enough to permit the springs 179 to again engage. The rotary magnet, upon energizing a second time, rotates the selector wipers a second step onto the terminals of the second trunk line. The wipers will thus be rotated step by step until the wiper 133 strikes the non-grounded contact of an idle trunk, whereupon the private magnet 140 becomes deënergized and allows the side switch to pass to the third position to break the operating circuit of the rotary magnet 135 at the wiper 138.

The movement of the side switch wipers 136 and 137 from second to third position disconnects the selector line relay 141 from the line and extends the line connection through the shaft wipers 131 and 132 to conductors 182 and 183 which lead to the connector F (Fig. 2). The extension of the connection to the connector causes its line relay 185 to become energized over a circuit extending from ground G^6 through winding 186 of relay 185, trunk conductor 183, and from conductor 183 the circuit extends over the heavy conductors of Fig. 1 to and through substation A and back to the connector F over the other side of the line, and through winding 187 of relay 185 to battery lead 168. The relay 185, upon energizing, operates to close a circuit through the relay 188, which corresponds to the relay 142 of the selector E. This circuit extends from ground G^7 through springs 189 and 190 and through relay 188 to battery lead 168. The closure of contact between springs 191 and 192 by the energization of relay 188 extends a circuit from ground G^8 through side switch wiper 193, springs 192 and 191 and conductor 184 to the private bank contact upon which the selector wiper 133 is resting, and to the corresponding contact in the private bank of all the selectors which have access to the trunk conductors 182 and 183. The ground potential upon the private bank contacts prevents any other selector E from stopping on the contacts of the busy trunk. From the private bank contacts a circuit also extends through the wiper 133 of the selector E over the conductor 180, through the side switch wiper 139 (in third position), springs 194 and 195 of the relay 144 and through the relay 142 to the battery lead 168. This circuit through the relay 142 is closed before the relay has time to deënergize after its former circuit is broken by the

deënergization of the relay 141 when the side switch leaves second position. A short period of time elapses between the time when the side switch of the selector passes to third position and the time when the relay 188 of the connector energizes. In order to supply a guarding potential to the selector private bank contacts during this short period of time the relay 144 is provided. It will be remembered that this relay 144 is included in the energizing circuit of the rotary magnet 136, and, since it is a slow-acting relay, it remains energized for an instant after the rotary magnet is energized the last time. Thus, at the instant the side switch wiper 139 reaches the third position a guarding potential is extended from ground G^9 through the springs 196 and 194, side switch wiper 139, conductor 180 and private wiper 133 to the private bank contacts. Of course, the relay 144 must be quicker than the relay 142 in order to close the circuit of the latter relay at the springs 194 and 195 before it has time to deënergize.

The central office apparatus is now in position for the reception of the impulses for the last two digits of the desired number, which digits affect the connector F to cause it to extend the connections to the desired line. The operation of the substation calling device for the second digit 2 opens the line circuit twice in the same manner as explained for the first digit. In this case, however, the opening of the line allows the line relay 185 of the connector F to be deënergized momentarily. Each time the relay 185 deenergizes it closes a circuit extending from ground G^7 through springs 189 and 197, 198 and 199, vertical magnet 200, side switch wiper 201 and private magnet relay 202 to battery lead 168. Since the digit called is 2 the vertical magnet receives two impulses, thus operating to raise the connector wipers 203, 204 and 205 two steps to a position opposite the second row of contacts, in which row are situated the terminals of line #220. The private magnet relay 202 operates in a manner similar to that of the relay 143 of the selector E to close the circuit of the private magnet 206 while the vertical magnet is operating. This circuit extends from ground G^{10} through springs 207 and 208 and magnet 206 to battery. Shortly after the last impulse of the second digit is delivered, the relay 202 deënergizes and opens the circuit of the private magnet 206, which in turn deenergizes to permit the side switch to pass to second position. The movement of side switch wiper 201 transfers the battery connection from the vertical magnet 200 to the rotary magnet 209. Each time the relay 185 deënergizes in response to the impulses for the last digit 0 a circuit is closed through the rotary magnet 209. This circuit extends from ground G^7 through springs 189 and 197, springs 198 and 199, springs 210 and 211, rotary magnet 209, contact point 212, side switch wiper 201 and relay 202 to the battery lead 168. Since the digit called is 0 the rotary magnet 209 receives ten impulses over this circuit, operating to rotate the wipers ten steps onto the contacts of the desired line. The private magnet relay 202 operates in the same manner as for the previous digit to close the circuit of the private magnet 206 while the impulses are being delivered.

After the last impulse for the last digit is delivered, the private magnet relay 202 deënergizes. If the desired line is idle when this relay deënergizes the private magnet 206 deënergizes also, permitting the side switch to pass from second to third position. The engagement of the side switch wipers 213 and 214 with their respective third-position contact points extends the connection from the calling line to the called line through the shaft wipers 203 and 204. The movement of side switch wiper 215 from second to third position establishes a guarding potential upon the connector private bank contacts of the called line, and also provides an energizing circuit for the cut-off winding 219 of the switch C′. This circuit extends from ground G^{13} through side switch wiper 215, springs 220 and 221, private wiper 205, bank contact 222 and corresponding contact in the other connectors which have access to line #220, and through winding 219 to battery lead 168. The winding 219, upon energizing, attracts the armature 223, which operates to disconnect the switch C′ from the called line and to extend connection from the contact upon which wiper 203 is resting to the line conductor 224. The movement of the side switch wiper 201 from second to third position disconnects the rotary magnet 209 from the battery and completes an energizing circuit for the ringer relay 149. This circuit extends from ground G^{12} through the interrupter 216, springs 217 and 218, relay 149, side switch wiper 201 and relay 202 to battery lead 168. The relay 149, upon energizing, shifts springs 226 and 229 out of engagement with springs 227 and 230 and into contact with springs 225 and 228, respectively, whereby the calling line is disconnected from the called line and the terminals of the ringing current generator L is bridged across the called line. Ringing current then flows from one terminal of the generator L through springs 225 and 226, wipers 213 and 203, springs 231 and 232, line 224, ringer 233, condenser 234, hook switch springs 235 and 236, line 237, wiper 204, side switch wiper 214, relay springs 229 and 228, back to the opposite terminal of the generator M. Since the energizing circuit of the ringer relay 149 includes the interrupter 216, this relay is energized only intermit-

tently, so as not to ring the bell 233 continuously. As soon as the receiver at the substation A′ is removed from the hook in answer to the signal, or as soon thereafter as the ringer relay is deënergized if it happens to be energized at the time, the substation is provided with talking current. The circuit over which this current flows extends from ground G^{13} through side switch wiper 215, winding 238 of relay 148, ringer relay springs 230 and 229, side switch wiper 214, wiper 204, line 237, receiver, calling device and transmitter at substation A′, hook switch springs 239 and 236, line 224, springs 232 and 231, wiper 203, side switch wiper 213, springs 226 and 227, and winding 240 of relay 148 to battery lead 168. The relay 148 is energized upon the completion of this circuit and, by separating springs 217 and 218, breaks the circuit of relay 149 to prevent the further application of ringing current to the called line.

After the conversation is completed the release of the central office apparatus is initiated by the restoration of the receiver to the switch hook at the calling substation. When the spring 11 disengages the spring 10 upon the hanging up of the receiver at the substation A, the circuit of the connector line relay 185 is permanently broken and the said relay deënergizes. The separation of springs 189 and 190 of the relay 185 destroys the energizing circuits of the release relays 188 and 142 of the connector F and selector E, respectively. Although it has not been stated, it is evident that by the passage of the connector side switch wiper 193 from second to third position, the holding ground of the release relay 142 of the selector E is transferred from the ground G^{8} to the ground G^{7}, which is connected with the third-position contact point of the side switch wiper 193 through the springs 189 and 190 as long as the relay 185 is energized. The relays 188 and 142 both deënergize shortly after their circuits are broken and operate to close the circuits of the release magnets of their respective switches. The circuit of the release magnet 241 of the connector F extends from ground G^{7} through the springs 189 and 197, 198 and 242, magnet 241 and off normal springs 343 and 344 to the battery lead 168. The circuit of the release magnet 145 of the selector E extends from ground G^{3} through the springs 165 and 166 of the relay 141, springs 169 and 170, magnet 145 and off normal springs 146 and 147 to the battery lead 168. The energization of the release magnet 241 allows the mechanism of the connector F to be restored to normal position, which breaks the connection with the called line and destroys the energizing circuit of the cut-off winding 219 of the individual switch C′. When the shaft of the switch returns to its lowest position the spring 343 is carried out of contact with the spring 344, which breaks the energizing circuit of the magnet 241, thus leaving all relays and magnets of the connector deenergized. The mechanism of the selector E is released by the energization of the magnet 145, after which the circuit of this magnet is broken by the separation of springs 146 and 147, when the switch shaft reaches its lowest position.

The deënergization of the relay 142 at the selector K not only closes the release circuit of that switch, as has been explained, but it also destroys the holding circuit of the winding 87 of the switch C by the separation of springs 172 and 173. The deenergizing of the winding 87 of the switch C allows the plunger arm 82 and cut-off armature 84 to be restored to their normal positions, and thus all the apparatus employed in establishing the connection is left in position for immediate use again.

In the foregoing it has been explained how connection is completed with an idle or non-busy line. It will now be explained how the connector F is prevented from completing the connection and the calling subscriber is given the busy signal in case the line wanted is already in use when called. When a busy line is called, the operations are just the same as those explained up to the point where the private magnet relay 202 of the connector deënergized after the impulses for the last digit had been delivered. From the description of the previous connection it is evident that whenever a line is in use, either by reason of having made a call or by having been called, there is present a guarding ground potential at the private bank contact of that line in the bank of each connector which has access to it. For busy calling lines this guarding potential is supplied by a selector switch, while for called lines the guarding potential is supplied by the connector switch by which the connection was completed. Thus it will be seen that had the line #220 been busy when called from substation A, there would have been present a guarding ground potential upon the private bank contact 222. At the instant the wiper 205 is rotated onto a contact that is thus grounded, this ground potential is extended through the springs 221 and 220 of the relay 243, winding 238 of the relay 148, ringer relay springs 230 and 229, side switch wiper 214 and contact point 244 to the spring 245 of the relay 202. When the relay 202 deënergizes, the spring 208 engages the spring 245 before it disengages the spring 207, and thus when the called line is busy the ground G^{10} is replaced by the ground at the private bank contact, which causes the private magnet 206 to remain energized, locking the side switch in second position. Since the wind-

ing 238 of the relay 148 is included in the locking circuit of the private magnet 206, this relay is energized also. The simultaneous energization of the relay 148 and private magnet 206, together with the de-energization of the relay 202, completes a circuit extending from ground G^{10} through springs 207 and 246, 247 and 248, relay 243 and springs 249 and 250 to battery lead 168. The relay 243, upon energizing, disconnects the rotary magnet 209 from the impulse spring 197, shifts the holding ground of the private magnet 206 and relay 148 to ground G^{14} without breaking its circuit and connects the busy signaling machine M with the calling line. The circuit over which the busy signaling curren' flows extends from the battery lead 168 through the secondary winding of the machine M, springs 251 and 252, side switch wiper 213 (which is locked in second position), ringer relay springs 226 and 227, condenser 253, thence over the heavy conductors shown in Figs. 2 and 1 to and through substation A and back over the other side of the line to and through the winding 186 of the connector line relay 185 to ground G^c, and thence through the battery B to the starting point. Of course, during the time the calling substation is receiving the busy signal, said substation has no connection with the called line, because the side switch wipers 213 and 214 are not allowed to pass to third position. The shifting of the holding ground of the private magnet 206 to ground G^{14} by the relay 243 prevents the connector F from completing the connection to the called line should the guarding potential be removed after the calling subscriber has begun to receive the busy signal and before the switches have been released. The switches are released from this position by the hanging up of the receiver at the calling substation in the same manner as when a successful connection is completed. Although the side switch is in second position the rotary magnet 209 is not operated in this case by the deënergization of the relay 185, because the circuit of said magnet is open at the springs 210 and 211.

From the foregoing it will be seen that I provide an automatic trunk-selecting switch having wipers which travel by a continuous motion from one trunk terminal to another, as distinguished from the step-by-step motion heretofore employed for this purpose, and in which the said continuous motion is supplied through an electric motor through the medium of a spring. The continuous motion of the wipers 124 from one trunk terminal to another is regulated or controlled by a governor, which prevents the wipers from moving too fast, and the motive power is always in readiness to supply the desired motion, as the spring 109 is normally under tension. All that is necessary is to simply release the governor, and the power of the said spring instantly starts the motion of the wipers 124, as well as the plungers of the line switches. When the governor is released by the energizing of the relay 116, the wipers of the switch may then move by one continuous motion from one end of the bank of line terminals to the other should the trunks all be busy. This, it will be seen, is different from the old arrangement in which the wipers have a step-by-step motion from one trunk terminal to another throughout the range of their motion, which step-by-step movement was accomplished by an electromagnetically-operated ratchet mechanism. With my improved arrangement, however, the circuit of the motor 101 is always closed, and the spring 109 is normally wound up, so that all that is necessary is to simply withdraw the brake or stop from the mechanism by which it is normally held against motion. In other words, the motive power is being exerted all the time, and to operate the mechanism all that is necessary is to simply release it by the energizing of a single relay.

What I claim as my invention is:—

1. In a telephone system, a plurality of trunks having terminals arranged in a row, a movable element adapted to move back and forth along said row of terminals, means including a spring for actuating said element in such back and forth movement, and electrically-operated means for winding up said spring.

2. In a telephone system, a plurality of trunks provided with terminals arranged in a row, a metallic wiper adapted to traverse said row of terminals in contact therewith, means including a spring for operating said wiper in such back and forth movement, and electrically-operated means for winding up said spring.

3. In a telephone system, a plurality of trunks provided with terminals arranged in a row, a metallic wiper adapted to travel along said row of terminals in contact therewith, means including a spring for propelling said wiper in its operative movement, electrically-operated means for winding up said spring, means normally locking the wiper against motion, electrically-operated means for unlocking the wiper, and means for causing the wiper to stop on the terminal of the first idle trunk.

4. In a telephone system, a plurality of trunks provided with terminals arranged in a row, mechanism for selecting idle trunk terminals, means including a spring for operating said mechanism, an electric motor for keeping said motor normally wound up, means for normally locking said mechanism

against operation, and an electro-magnet for unlocking the mechanism to permit operation thereof by the said spring.

5. In a telephone system, a plurality of trunks provided with terminals arranged in a row, means for traversing said row of terminals to select idle trunks, an operating mechanism for said means comprising a gear wheel and a governor wheel, a spring connecting said wheels, means for operating one wheel to wind up said spring, means on said wheels for stopping the motion of the one wheel when the spring is wound up, a governor controlling the motion of the governor wheel, a catch normally engaging said governor to prevent motion of said mechanism, and a magnet for operating said catch to permit selection of an idle trunk.

6. In a telephone system, a plurality of trunks provided with terminals arranged in a row, mechanism for selecting idle trunk terminals, a motor normally under current for supplying power to operate said mechanism, means for normally locking said mechanism against operation, and means for unlocking the mechanism to permit selection of an idle trunk.

7. In a telephone system, a plurality of trunks provided with terminals arranged in a row, mechanism for automatically selecting idle trunk terminals, means normally exerting power to operate said mechanism, means for normally holding the said mechanism stationary, and means for releasing said mechanism to permit selection of an idle trunk.

8. In a telephone system, a plurality of non-numerical trunking switches, each switch provided with a bank of trunk terminals, a plunger for each bank of terminals, a shaft for operating said plungers, and an electric motor normally under current for operating said shaft.

9. In a telephone system, a plurality of non-numerical trunking switches, each switch provided with a bank of trunk terminals, a plunger for each bank of terminals, a shaft for operating said plungers, an electric motor normally under current for operating said shaft, and a spring interposed between said electric motor and said shaft.

10. In a telephone system, a plurality of non-numerical trunking switches, each switch provided with a bank of trunk terminals, a plunger for each bank of terminals, a shaft for operating said plungers, an electric motor normally under current for operating said shaft, means for holding the shaft stationary, and means for unlocking the shaft to permit rotation thereof by said motor.

11. In a telephone system, a plurality of non-numerical trunking switches, each switch provided with a bank of trunk terminals, a plunger for each bank of terminals, a shaft for operating said plungers, an electric motor normally under current for operating said shaft, a spring interposed between said electric motor and said shaft, means for holding the shaft stationary, and means for unlocking the shaft to permit rotation thereof by said motor and spring.

12. In a telephone system, a plurality of trunk terminals, mechanism for automatically selecting idle trunk terminals, and means for operating said mechanism comprising a wheel with a ball and socket joint thereon, said joint being adjustable toward and away from the axis of said wheel, an arm engaging said ball and socket joint, and an oscillating shaft operated by said arm.

13. In a telephone system, a plurality of trunks, mechanism for automatically selecting idle trunks, a governor for controlling said mechanism, means normally locking the governor against motion to prevent operation of said mechanism, and means for unlocking said governor to permit operation of said mechanism.

14. In a telephone system, a plurality of trunks, mechanism for automatically selecting idle trunks, and means for operating said mechanism comprising an oscillating element, an arm by which said element is operated, and rotary means for operating said arm, said rotary means provided with a portion which engages said arm and which is adjustable toward and away from the axis of said rotary means to vary the stroke of said arm.

15. In a telephone system, a plurality of trunk terminals, mechanism for automatically selecting idle trunk terminals, and means for operating said mechanism comprising a wheel, a ball mounted in an opening in said wheel, an arm engaging said ball, and an oscillating shaft operated by said arm.

16. In a telephone system, a plurality of trunk terminals, mechanism for automatically selecting idle trunk terminals, and means for operating said mechanism comprising a wheel, a ball mounted in an opening in said wheel, an arm engaging said ball, an oscillating shaft operated by said arm, and means for adjusting said ball toward and away from the axis of said wheel.

17. In a telephone system, a plurality of trunk terminals, mechanism for automatically selecting idle trunk terminals, means for operating said mechanism, said means including a rotary element and an oscillating element, and means by which the rotation of said first element oscillates said second element, said means including an arm connected to said oscillating element and engaging a ball held within said rotary element.

18. In a telephone system, a plurality of trunk terminals, mechanism for automatically selecting idle trunk terminals, means for operating said mechanism, said means including a rotary element and an oscillating element, means by which the rotation of said first element oscillates said second element, said means including an arm connected to said oscillating element and engaging a ball held within said rotary element, and means for adjusting the position of said ball in said rotary element.

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

MICHAEL SETTER.

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