June 8, 1926. 1,587,620

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TELEPHONE EXCHANGE SYSTEM

Filed June 14, 1924 4 Sheets-Sheet 1

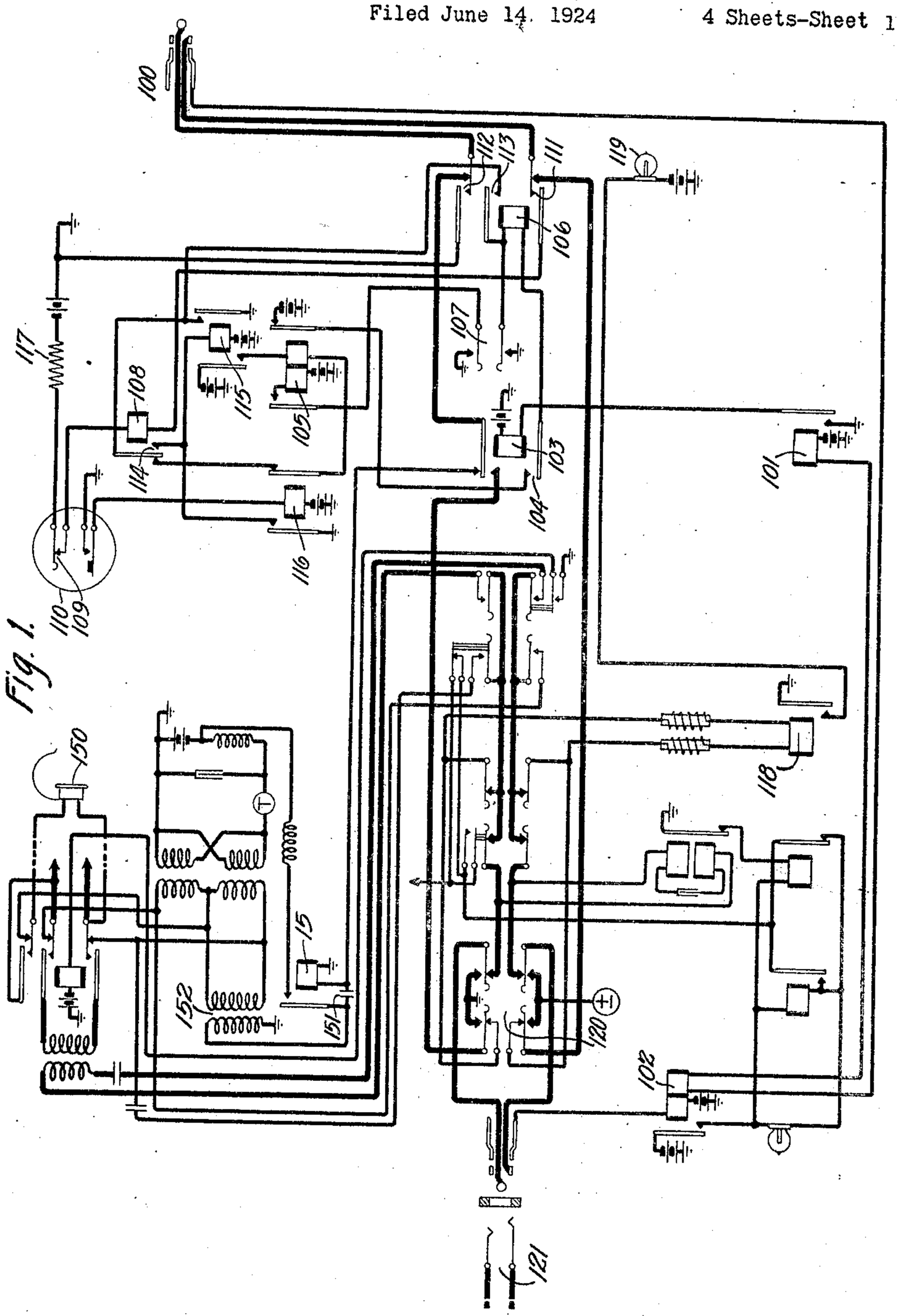

Fig. 1.

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4 Sheets-Sheet 2

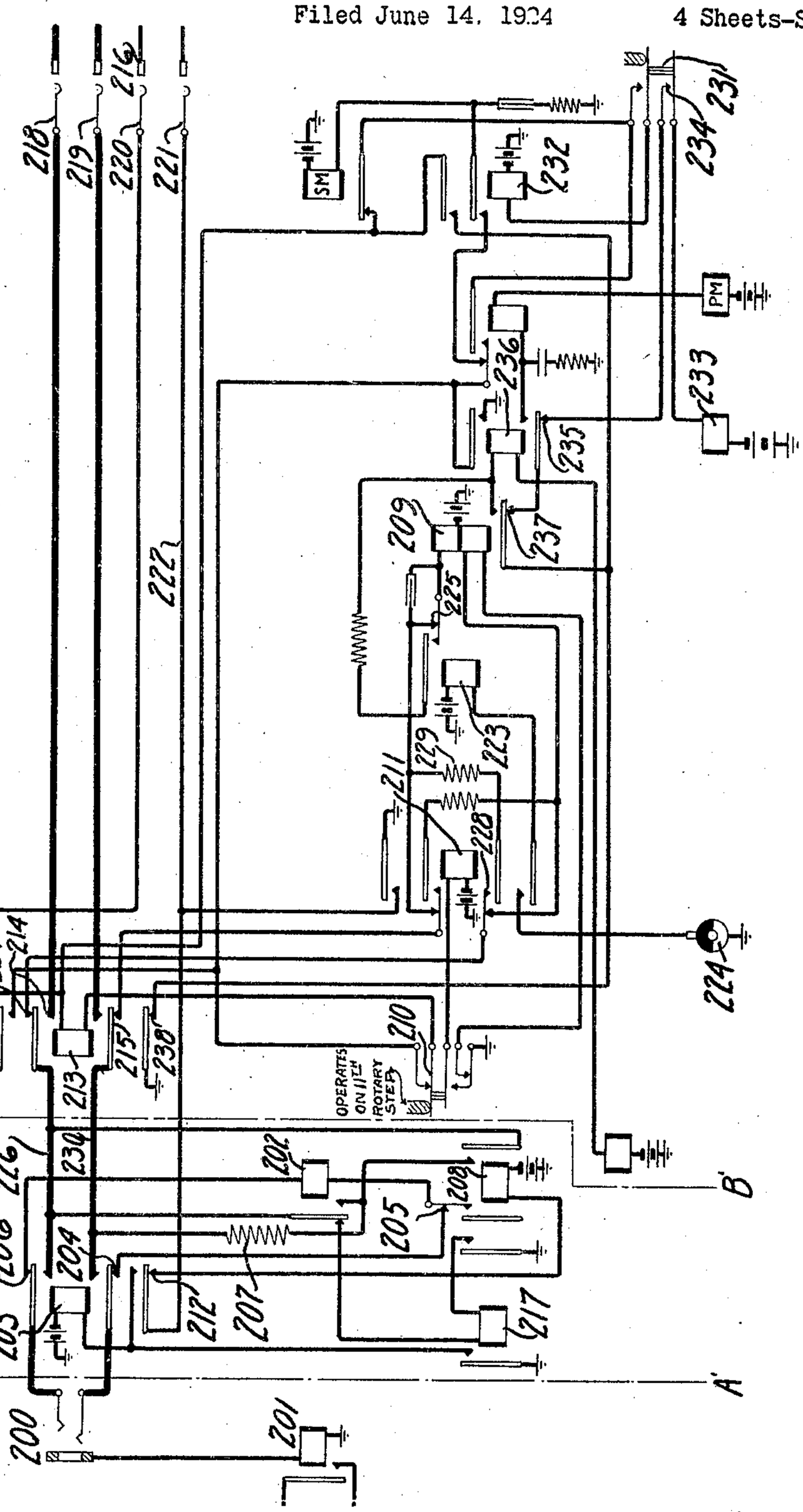

Fig. 2.

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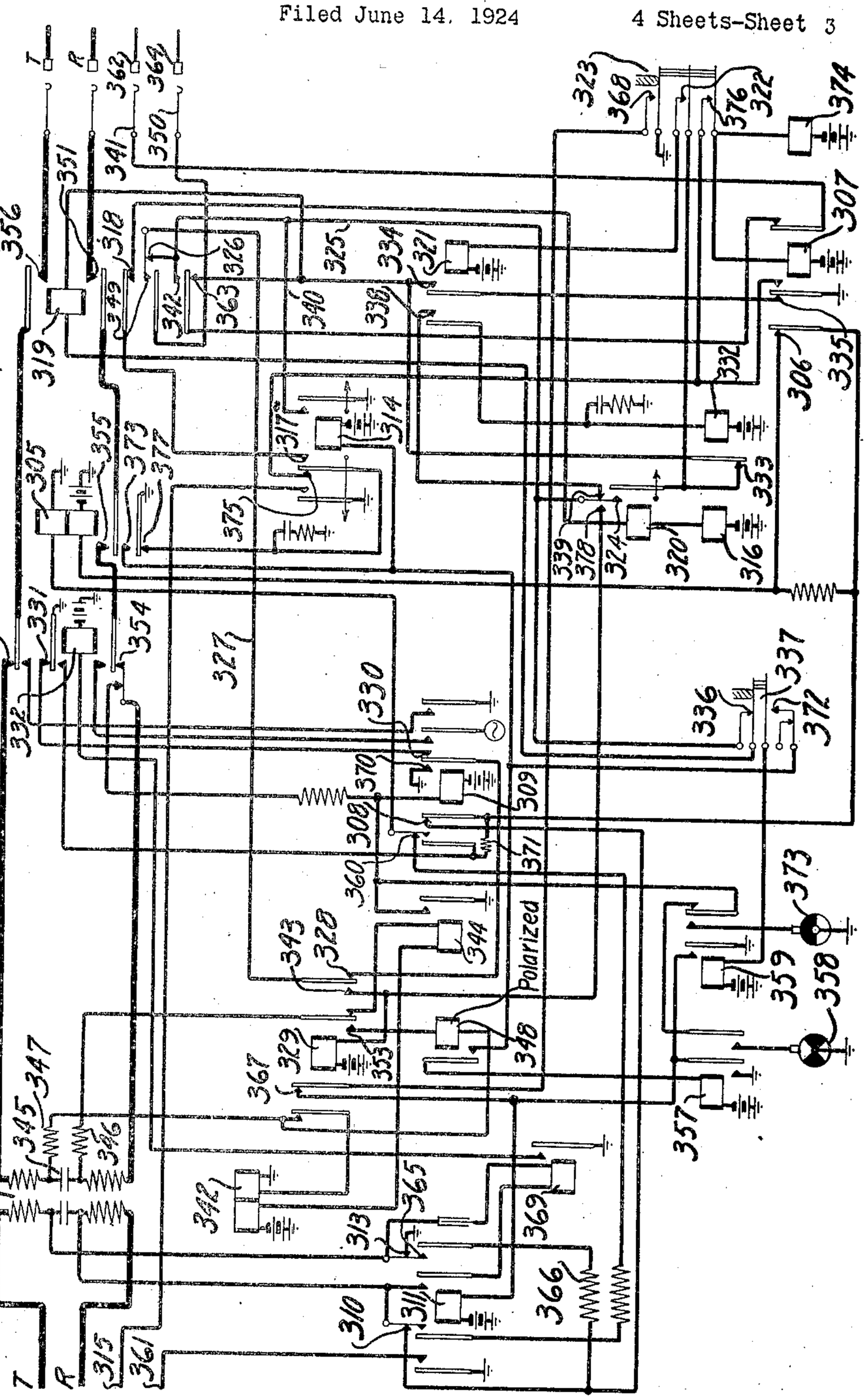
4 Sheets-Sheet 3

Fig. 3.



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TELEPHONE EXCHANGE SYSTEM

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4 Sheets-Sheet 4

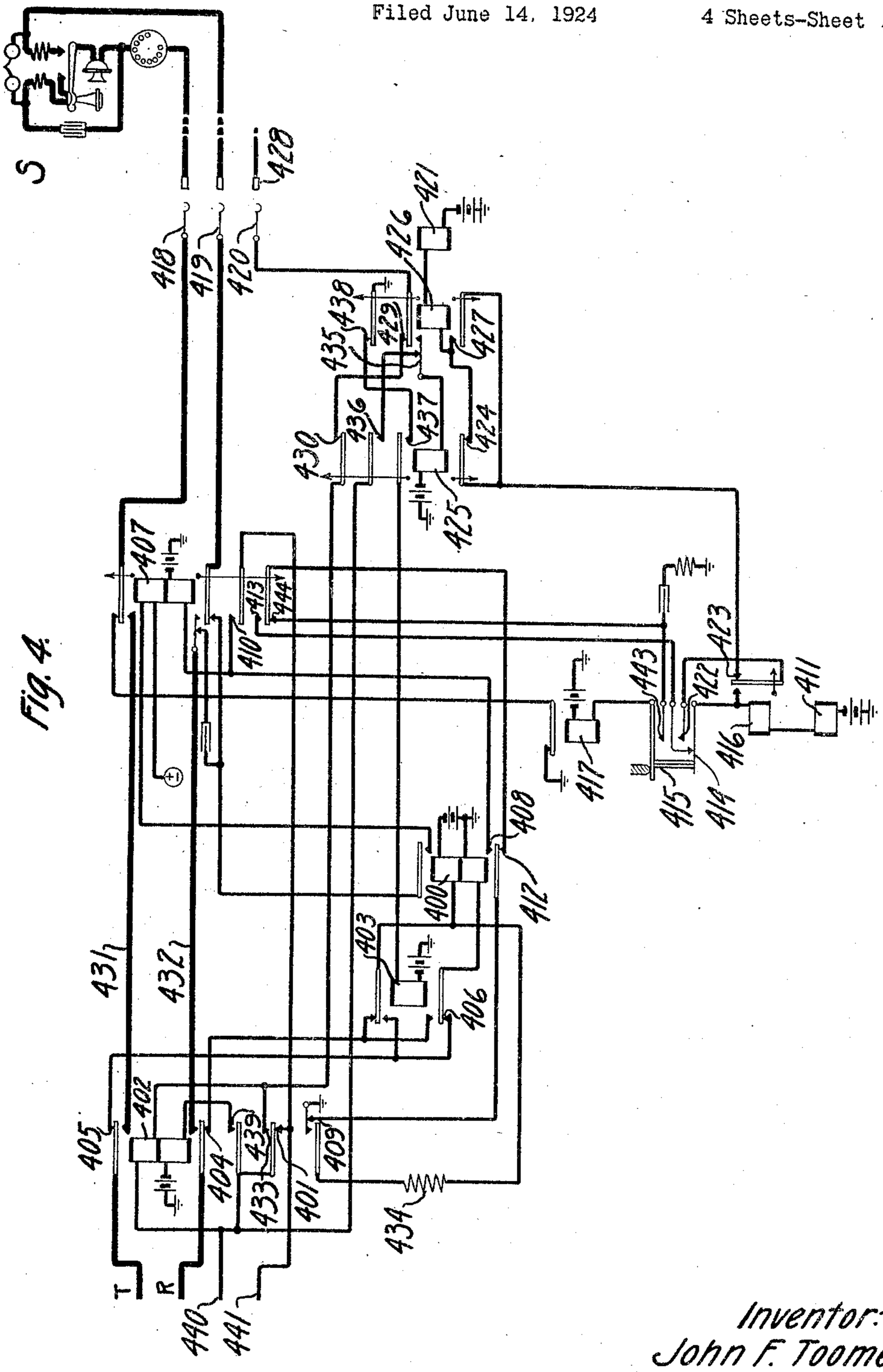

Fig. 4.

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Patented June 8, 1926. 1,587,620

UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

Application filed June 14, 1924. Serial No. 720,084.

This invention relates to telephone exchange systems and more particularly to circuit arrangements for enabling toll operators to build up toll connections with automatic subscribers' lines.

The object of this invention is to improve the operating efficiency of, and effect equipment economies in, circuits of this character.

A feature of the invention resides in supplying the dialing current from the operator's dialing circuit at the outgoing end of the toll switching trunk and receiving and translating this current at the distant or machine switching end of the trunk into the usual pulses for setting the switches thereat, whereby a normally "dry" (i. e., battery free) trunk is secured.

A more specific feature to the above resides in providing pulsing and cut-through equipment at the incoming or machine switching end of the trunk circuit, which includes a pulsing relay bridged across the trunk which is controlled by the operator's dialing battery and which, in turn, controls the pulsing relays of the automatic switches.

Other features will appear hereinafter.

Referring to the drawings, Figure 1 shows a toll cord circuit, an operator's telephone circuit and associated dialing equipment.

Fig. 2 shows at the left of the broken line AA′ an outgoing trunk circuit to a machine switching office, between the broken lines AA′ and BB′ the pulse translating equipment at the machine switching office, and to the right of the broken line BB′ an incoming selector.

Fig. 3 shows a toll transmission selector and Fig. 4 shows a toll connector.

In general in the system of this invention the toll operator's position is provided with a number of toll cords similar to that shown in Fig. 1 and with the telephone and dialing circuit also shown in Fig. 1 which is common to all these toll cords. When the operator desires to build up a toll connection she inserts plug 100 in the jack 200 of an idle outgoing toll switching trunk leading to the desired machine switching office and actuates the dialing key 107 of the toll cord taken for use. This key when operated completes a circuit for relay 106 in the toll cord which was prepared by the operation of relay 103 when the plug was inserted in the jack 200. Relay 106, in operating, disconnects the calling plug 100 from the remainder of the cord circuit and connects the common dialing circuit shown in the upper half of Fig. 1 to the calling plug. The operation of relay 106 closes a circuit for relay 108 of the dialing circuit which is completed through relay 202 (Fig. 2) at the machine switching office, both of which relays operate in series with battery associated with the dial. Relay 202 in operating connects a bridge including resistance 207 across the tip and ring conductors 226 and 230 leading to the incoming selector shown to the right of the broken line BB′, thus starting its operation preparatory to receiving the pulses. Relay 108 extends the ground supplied from the dialing key to relay 115 thereby causing its operation, which in turn, supplies ground to hold both itself and relay 106 operated independent of the dial key 107 which can now be released.

When the dial 109 is moved off-normal relay 116 is operated, thus breaking the circuit for relay 105 and preventing the premature release of the dial circuit when relay 108 releases as it follows the dial pulses. Relay 116 also furnishes ground to hold relay 115 operated until the dial returns to normal.

As the dial returns to normal relay 202 of the pulsing circuit (Fig. 2) follows the pulses, thereby alternately making and breaking the bridge across the tip and ring conductors leading to the incoming selector, which selector is actuated in response to these pulses in the usual manner. If the paths busy or line busy is encountered or if the called line is seized, ground is connected to the conductor 222, which causes the operation of the relay 208, which momentarily opens the circuit for relay 108 in the dialing circuit, which relay falls off and closes a circuit for relay 105 which operates and removes battery from relay 106, thereby causing its release. The disconnection of the dial circuit from the cord restores the continuity of the cord circuit.

At the machine switching office when relay 208 operated and relay 202 released, the bridge across the conductors 226 and 230 leading to the incoming selector was opened at the alternate contacts of relay 202, but this bridge was closed when relay 208 operated so that the selector was not affected. Relay 208 in operating also closes a circuit for relay 217 which relay, in operating,

caused relay 203 to operate. When relay 203 operated it locked up to the connector 222 and at the same time opened the energizing circuit for relay 208, thereby allowing it to release. When relay 203 operated it disconnected the pulsing relay 202 and extended the tip and ring conductors of the trunk through to the incoming selector, and a supervisory signal will thereafter come back over the tip and ring conductors of the trunk to operate the calling supervisory relay 118 and calling supervisory lamp 119 associated with the cord circuit in the usual manner.

Having described in a brief way the operation of the system embodying the present invention, a more detailed description will now be given. The toll operator having received the number of the desired station from the recording operator or in any other suitable manner touches the tip of her plug 100, to the sleeve of jack 200 to select an idle trunk leading to the machine switching office in which the desired line terminates and if it is idle inserts the plug in the jack of such idle trunk. A busy condition of the line is indicated by battery on the sleeve of the jack 200 which produces a click in the receiver 150 of the operator's head set in the following manner: battery from the sleeve of the jack 200 over the tip of the plug 100 and upper normal contacts of relays 106 and 103 charges the condenser 151 which discharges to ground through the left-hand winding of repeating coil 152. This causes an induced current to flow in the right-hand winding of coil 152 and a consequent click in the receiver 150 due to the fact that the receiver winding is normally connected across the terminals of this coil winding.

Insertion of the plug 100 in an idle jack 200 completes an obvious circuit for the energization of relay 101. Relay 101 in operating closes an obvious circuit to operate relay 103 which relay at its lower alternate contact 104 prepares a circuit for relay 106 which is operated as soon as dial key 107 is operated. Relay 106 in operating connects the tip and ring conductors of the cord through to the dialing circuit thereby causing the operation of relay 108 in the dialing circuit and relay 202 in the pulsing circuit at the distant machine switching office. This circuit may be traced from battery through resistance 117, pulsing contact 109 of the dial 110, winding of relay 108, contacts 111 of relay 106, ring contacts of the plug 100 and jack 200, contacts 204 of relay 203, contacts 205 of relay 208, winding of relay 202, contacts 206 of relay 203, tip contacts of jack 200 and plug 100, contacts 112 of relay 106, to ground. Relay 202 in operating bridge resistance 207 across the tip and ring conductors of the trunk extending to the first or toll selector, which is shown at the right of line BB′ of Fig. 2, thereby causing relay 209 to operate to prepare this selector for the reception of impulses. Relay 108 in operating extends the ground received from the dial key 107 to the winding of relay 115, thereby causing its operation. This circuit can be traced from grounded battery, winding of relay 115, alternate contact 114 of relay 108, alternate contacts 113 of relay 106 and to ground at the lower contact of dial key 107. Relay 115 in operating supplies ground for itself at its right-hand alternate contact and also for relay 106 thereby making these relays independent of the dial key 107. The operator now turns the dial 110 to the first digit of the wanted number. When the dial is moved off normal, relay 116 operates in an obvious circuit thereby breaking the circuit for relay 105 and preventing the premature release of the dial circuit when relay D releases and closes its alternate contact following the dial pulses. Relay 116 in operating also supplies ground at its left-hand alternate contact to hold relay 115 operated until the dial returns to normal.

As the dial 110 returns to normal relay 202 of the pulsing circuit (Fig. 2) is released and energized in accordance with the opening and closing of the dial contacts 109 thereby alternately opening and closing the bridge consisting of resistance 207 across the tip and ring conductors of the trunk leading to the first selector. The first selector circuit shown at the right of line BB′ in Fig. 2 functions in the well known manner as described in Patent 1,377,225, issued May 10, 1921 to A. J. Seymour and its operation will therefore not be described in detail, it being sufficient to mention that as the dial returns to normal the vertical or primary magnet PM of the selector receives impulses from the impulse relay 209 in the well known manner and raises the selector brushes 218, 219, 220, 221 to the desired level after which the rotary or secondary magnet SM is energized and causes the brushes to hunt for an idle trunk leading to the toll transmission selector (Fig. 3). In the case of the first selector finding all the trunks busy in the selected group leading to the toll transmission selector Fig. 3, switch 210 will be operated on the eleventh rotary step of the selector thus closing an obvious energizing circuit for relay 211 which upon operating connects ground at its uppermost contact to the lead 222, thereby causing the operation of relay 208, a circuit for which can be traced from grounded battery through the winding of this relay, contacts 212 of relay 203 and to ground at the uppermost contact of relay 211. Relay 208 in operating opens at contacts 205 the circuit for relay 108 in the

dialing circuit which relay then releases and closes at its alternate contact the circuit for the energization of relay 105 which circuit can be traced from battery, left-hand alternate contact of slow-to-release relay 115, right-hand winding of relay 105, right hand normal contact of relay 116, (this relay being released due to the normal condition of the dial at this time) normal contact of relay 108 and to ground at the right-hand alternate contact of relay 115. Relay 105 in operating opens at its right-hand normal contact the energizing circuit for relay 106 which relay now releases thereby disconnecting the dialing circuit from the cord and restoring the cord to normal.

Relay 211, in operating, also reverses and reduces the current supplied to the trunk from relay 209, and at the same time connects grounded interrupter 224 through relay 223 to battery, thereby causing this relay to alternately open and close contacts 225 at the rate of 60 interruptions per minute.

When relay 208 operated, it closed its right alternate contacts,which prevented the trunk bridge from being open when contacts 205 were broken. Relay 208, in operating, also supplied ground at its outer left alternate contacts to prepare an energizing circuit for relay 217 under control of the alternately operating relay 223, which circuit can be traced from ground through left contacts of relay 208, winding of relay 217, normal contacts of relay 202, tip conductor 226 of the trunk, contacts 227 of relay 213, contacts 228 of relay 211, resistance 229, contacts 225 of relay 223 and upper winding of relay 209 to grounded battery.

On the first closure of contacts 225, relay 217 operates and closes an obvious energizing circuit for relay 203, which relay operates and locks to ground supplied in the uppermost contacts of relay 211 over the conductor 222,

Relay 203, in operating, disconnects the pulsing relay 202 from the trunk and opens the energizing circuit for relay 208, which relay now releases and removes the bridge including resistance 207 from across the conductors 226 and 230.

The trunk is now cut through to the first selector and receives the interrupted, reversed and reduced current which is transmitted to the cord circuit, where it causes the alternate operation of the bridged supervisory relay 118 in the well known manner, which supervisory relay causes supervisory lamp 119 to flash in step with interrupter 224 to indicate to the operator that a busy trunk group has been encountered and that it will be futile to continue dialing, whereupon the plug is withdrawn and the circuit at once restores to normal. If, however, the first selector (Fig. 2) finds an idle trunk, relay 213 operates and cuts off the bridge containing the impulse relay 209 and extends the trunk conductors through to the toll transmission selector (Fig. 3) whereupon the impulse relay 305 operates in the following circuit: battery, lower winding of relay 305, contacts 306, of relay 307, contacts 308 of relay 309, contacts 310 of relay 311, lower left-hand winding of repeating coil 312, ring conductor of the trunk, brush 219, contacts 215 of relay 213, conductor 230, resistance 207, alternate contacts of relay 202, conductor 226, contacts 214 of relay 213, brush 218, upper left-hand winding of repeating coil 312, and to ground at contacts 313 of relay 311.

Relay 305 operates in the before traced circuit and in attracting its lowermost armature closes an obvious energizing circuit for slow-to-release relay 314. Relay 314 in energizing connects ground at its outer left-hand alternate contact over conductor 315 to cause this trunk to test busy in the well known manner.

The second operation of the dial causes relay 305 to transmit impulses over the following circuit to the vertical magnet 316, ground, lowermost normal contact of relay 305, contacts 317 of relay 314, contacts 318 of relay 319, windings of relay 320 and magnet 316 to grounded battery. The brushes of the selector are thus elevated to the level of the trunks leading to the desired connector group terminal. When the dial returns to normal and maintains relay 305 energized, slow relay 320 after a short interval releases.

When slow-to-release relay 320 operated on the first impulse and the selector took its first step, relay 321 operated in the following circuit; battery, winding of relay 321, contacts 322 of the off-normal switch 323, contacts 324 of relay 320, conductor 325, contacts 326 of relay 319, conductor 327, contacts 328 of relay 329, contacts 330 of relay 309 and contacts 331 of relay 332 to ground. Relay 321 in operating locks itself up to ground at the left normal contacts 335 of relay 307. This locking circuit may be traced from battery, winding of relay 321, contacts 322 of switch 323, contacts 333 of relay 332, contacts 334 of relay 321 and to ground over contacts 335 of relay 307.

Relay 321 in operating also closes a shunt circuit around relay 319 which can be traced as follows: ground, contacts 335 of relay 307, contacts 334 of relay 321, winding of relay 319, contacts 336 of switch 337, conductor 340 and to ground at the right-hand alternate contacts of relay 314. Upon the cessation of the impulses and the release of slow relay 320, the circuit of the rotary magnet 332 is closed as follows: battery, winding of relay 332, contacts 338 of relay 321, contacts 339 of relay 320, conductors

325 and 340 to ground at the right alternate contact of relay 314. The rotary magnet 332 advances the brushes to the terminals of the first trunk and if it is not busy no ground will be present on the sleeve terminal 362 and the locking circuit of relay 321 will therefore be opened at the contacts 333 of the rotary magnet 332 and relay 321 will release thus breaking at contacts 334, the shunt circuit around relay 319 which was applied when relay 321 operated. The circuit for rotary magnet 332 is also opened at contacts 338 upon the release of relay 321. When the armature of rotary magnet 332 retracts it closes a circuit for the operation of relay 319 which can be traced as follows: battery, winding of relay 321, contacts 322 of switch 323, contacts 333 of relay 332, winding of relay 319, contacts 336 of switch 337 and to ground at the right-hand alternate contact of relay 314. Relay 319 alone energizes in this circuit relay 321 being marginal and not capable of operating in series with relay 319.

If the first trunk is busy its sleeve terminal 362 will be grounded. In this case relay 321 releases as usual upon the energization of rotary magnet 332 but relay 319 will not operate as it is still shunted by ground supplied from terminal 362 on the right normal contacts of relay 307 and contact 363 of relay 319. When the rotary magnet 332 releases, relay 321 again energizes which in turn causes magnet 332 to operate and the brushes are stepped forward to a second set of terminals. This operation is continued until an idle trunk is found.

When an idle trunk is reached, relay 319 operates as before described and extends the tip and ring conductors of the trunk to the selector brushes which are now in engagement with an idle connector (Fig. 4). Relay 319 in operating also grounds the sleeve brush 341, and consequently the test multiples of the selected trunk, thereby causing them to test busy to other selectors. This circuit can be traced as follows: ground, right alternate contact of relay 314, conductor 340, contacts 342 of relay 319, right normal contact of relay 307, and thence to brush 341 and terminal 362. Relay 319 in operating also opens at its contact 318 the circuit for vertical magnet 316.

When relay 320 was first actuated relay 329 was operated over the following circuit: ground, right alternate contact of relay 314, contacts 378 of relay 320 and winding of relay 329 to battery. Relay 329 in operating locked up in the following circuit: battery, winding of relay 329, contacts 343 of relay 329, conductor 327, contacts 326, of relay 319, conductor 340, and right alternate contacts of relay 314 to ground. Relay 329 in operating also opens the circuits for relays 344 and 311 and shunts the condenser 345 by resistance 346 and 347 and the polarized relay 348, so that the pulsing relay 400 (Fig. 4) will operate when the connection is extended to the connector.

When relay 319 operated it closed its alternate contacts 349 before it opened the normal contacts 326 so that relay 329 is maintained locked in a circuit which now can be traced as follows: battery, winding and outer alternate contacts 343 of relay 329, conductor 327, contacts 349, brush 350, terminal 364, contacts 401 of relay 402, terminal 362 (Fig. 3), brush 341, right normal contacts of relay 307, contacts 342 of relay 319, conductor 340 and to ground at the right alternate contact of relay 314.

Thus the circuit of relay 329 will be maintained closed if the circuit is extended for a purpose which will later appear.

The seizure of the trunk leading to the connector (Fig. 4) closes the following circuit for the pulsing relay 400: battery, upper winding of relay 400, upper normal contacts of relay 403, contacts 404 of relay 402, conductor R, of the trunk, terminal and brush of the selector switch, contacts 351 of relay 319, contacts 352 of relay 332, lower right-hand winding of repeating coil 312, resistance 346, contacts 353 of relay 329, winding of polarized relay 348, resistance 347, upper right-hand winding of repeating coil 312, contacts 354 of relay 332, contacts 355 of relay 305, contacts 356 of relay 319, brush and terminal of the selector switch, contacts 405 of relay 402, contacts 406 of relay 403 and to ground through the lower winding of relay 400. Relay 400 is energized in this circuit and closes a circuit for the energization of relay 407 which can be traced as follows: grounded battery, lower winding of relay 407, contacts 408 of relay 400 and to ground at contacts 409 of relay 402. Relay 407 operates and locks up at its contacts 410 to the sleeve conductor 440 which is grounded at relay 314 (Fig. 3).

The return of the dial to normal transmitting the tens digit of the wanted number interrupts the circuit for relay 202 of Fig. 2 which in turn alternately breaks and makes the bridge including resistance 207 across the trunk which in turn alternately interrupts at contacts 355 of relay 305 the circuit of relay 400. The lower armature of relay 400 therefore follows the dial pulses and in its turn transmits impulses to the vertical magnet 411. The circuit for the first impulse is as follows: ground, contacts 409 of relay 402, alternate contacts 412 of relay 400, contacts 413 of relay 407, contacts 414 of the off-normal switch 415, windings of slow-to-release relay 416 and vertical magnet 411 to grounded battery. The off-normal switch

415 is operated on the first vertical step of magnet 411 thereby switching the impulse circuit from its normal to its alternate contact and over the alternate contact of the slow-to-release relay 416 which was operated on the first impulse. The off-normal switch 415 in operating also prepares a circuit for the operation of the release magnet 417.

After the last impulse of the series, the brushes 418, 419 and 420 will be elevated to the desired level and relay 416 will be deenergized thus switching the pulsing circuit to the rotary magnet 421, the circuit for which can be traced as follows: ground over contacts 409 of relay 402, contacts 412 of relay 400, contacts 413 of relay 407, contacts 422 of the off-normal switch 415, contacts 423 of relay 416, contacts 424 of relay 425, winding of slow-to-release relay 426 and winding of the rotary magnet 421 to grounded battery. As the last series of impulses comes in the lower armature of relay 400 drops back in step therewith and moves the brushes 418 and 419 into engagement with the desired subscriber's line. When relay 426 operated it transferred the pulsing circuit from the normal contact of relay 425 to its own alternate contact 427.

As soon as slow-to-release relay 426 releases, if the called line is idle, it closes a circuit for the operation of relay 402 which can be traced as follows: battery (not shown), sleeve terminal 428 of the subscriber's line, brush 420, contacts 429 of relay 426, contacts 430 of relay 425, upper winding of relay 402, terminal 362 (Fig. 3), brush 341, right normal contact of relay 307, contacts 342 of relay 319, conductor 340, and ground at the right alternate contact of relay 314. Relay 402 operates in this circuit and locks to ground at its contacts 439 over the just traced circuit. Relay 402 in operating also connects the tip and ring conductors of the trunk through to conductors 431, 432 and places ground on the multiple test terminals of the seized subscriber's line in the following circuit: ground, right-hand alternate contact of relay 314 (Fig. 3), conductor 340, contacts 342 of relay 319, right normal contacts of relay 307, brush 341 and terminal 362, contacts 433 of relay 402, contacts 430 of relay 425, contacts 429 of relay 426 and brush 420 which is in contact with test terminal 428 of the called subscriber's line. Further, relay 402 in attracting its lowermost armature removes ground from the lower armature of relay 400 and tranfers this ground through a resistance 434 to hold relay 400 operated during the continuance of the connection in order that the ringing current circuit which extends through the upper alternate contact of relay 400 will not be broken at this point.

If the called line is found busy ground will be present on the test terminal 428 and before slow relay 426 has time to release, relay 425 which is also slow-to-release will be energized thus breaking the pulsing circuit branch at its contacts 424. When relay 426 finally releases, relay 425 locks up to ground on the conductor 440, this can be traced from battery, winding of relay 425, normal contacts 435 of relay 426, contacts 436 of relay 425 and to ground on conductor 440 as previously traced which is supplied at the right-hand alternate contact of relay 314 of Fig. 3. Relay 425 in operating also connects ground to operate the reverse relay 403 which circuit can be traced from battery, winding of relay 403, contacts 437 of relay 425 and contacts 438 of relay 426 to ground. Relay 403 now operates and reverses the current flowing back over the trunk to the toll transmission selector Fig. 3 where it operates polarized relay 348 bridged at the center of the right-hand winding of repeating coil 312 in series with resistances 346 and 347.

Polar relay 348 in operating closes a circuit for relay 357 which may be traced as follows: battery, winding of relay 357, and contacts of relay 348 to ground at the lower alternate contact of relay 305. Relay 357 closes an obvious energizing circuit for reverse relay 311 which now operates and reverses and reduces the current in the loop circuit leading back toward the toll office.

Relay 311 in operating connects ground over its outer left alternate contact to the conductor 361 thereby causing relay 208 in the pulse translating equipment (Fig. 2) to operate. Relay 208 in operating momentarily opens, at its contacts 205, the energizing circuit for relay 108 in the operator's dialing equipment (Fig. 1). Relay 108 in releasing closes a circuit for the energization of relay 105. This circuit may be traced from battery, left-hand alternate contact of relay 110, right-hand winding of relay 105, right-hand normal contacts of relay 116, normal contacts of relay 108, and to ground at the right-hand alternate contacts of relay 115. Relay 105 operates in this circuit and disconnects battery at its right-hand normal contact thereby causing the release of relay 106 in the cord circuit. The deenergization of relay 106 releases the dialing circuit and restores the cord to normal. When relay 208 operated and relay 202 released the bridge including resistance 207 across the trunk circuit was opened at the alternate contacts of relay 202 but this bridge had previously been closed at the right-hand alternate contacts of relay 208 when this relay operated, so that the selector circuit was not affected. Relay 208 in operating also closed a circuit for relay 217, which can be traced from ground, outer left alternate contacts of

relay 208, winding of relay 217, normal contacts of relay 202, conductor 226, contacts 214 of relay 213, brush 218, conductor T (Fig. 3), upper left winding of repeating coil 312, contacts 365 of relay 311, resistance 366, contacts 308 of relay 309, contacts 306 of relay 307 and lower winding of relay 305 to grounded battery.

Relay 217 operates in this circuit and closes an obvious circuit for cut-through relay 203, which relay operates and locks up to ground on conductor 222, which ground is supplied at the left-hand alternate contacts of relay 311.

The operation of relay 203 opens the circuit for relay 208 which relay releases and opens the bridge across conductors 226 and 230.

Relay 203, in operating, also disconnects the pulsing relay 202 from the trunk and extends the trunk through to the machine switching equipment.

Relay 357, in operating, also connects ground through interrupter 358 to alternately operate busy back relay 309, which relay, in turn, alternately opens and closes at its contacts 308 the loop circuit leading back to the toll office where it causes the supervisory relay 118 bridged across the cord to operate in step with the interrupter and flash lamp 119 as a signal that the called line is busy. In practice interrupter 358, for giving a line busy signal, is arranged to interrupt the circuit at the rate of one hundred and twenty interruptions per minute.

If the subscriber's line is not busy it is seized and relay 402 operates as before described. Relay 402, in operating opens at its contacts 401 the previously traced circuit for relay 329, which relay in turn releases and closes at its contacts 367 a circuit for the operation of reverse relay 311, which may be traced as follows: battery, winding of relay 311, contacts 367 of relay 329 and contacts 368 of off-normal switch 323 to ground.

When relay 329 releases it provides a substitute ground connection for the locking circuit of relay 407 so that this relay will not be deenergized when relay 402 is operated. This circuit may be traced as follows: grounded battery, lower winding of relay 407, contacts 410 of relay 407, conductor 441, terminal 364 and brush 350, Fig. 3, contacts 349 of relay 319, conductor 327, contacts 328 of relay 329, contacts 330 of relay 309 and contacts 331 of relay 332 to ground.

When relay 311 operates in the circuit just traced it reverses and reduces the current flowing in the loop circuit extending back to the pulse repeating equipment of Fig. 2, which circuit includes the impulse relay 305 of the toll transmission selector.

Relay 311 in operating also connects ground at its outer left contacts to the lead 361 which causes relays 208, 217 and 203 to operate and the consequent release of the dialing equipment of Fig. 1 as previously described in connection with the line busy condition. With relay 203 operated and locked up to ground on lead 222, the loop circuit is now extended back to the toll cord and current flowing in this loop circuit causes the steady operation of supervisory relay 118 and the consequent lighting of supervisory lamp 119 which serves as an indication to the operator that the building up of the connection has progressed properly to the subscriber's line and that she can now start ringing the called subscriber which is accomplished by depressing ringing key 120.

The ringing current thus sent over the trunk from the cord circuit causes the operation of alternating current relay 369 over an obvious circuit. Relay 369, in operating, closes at its alternate contacts an obvious circuit for the operation of relay 332. Relay 332, in operating, opens at its contacts 331 the locking circuit for relay 407, which relay now releases and applies ringing current in series with its upper winding to the subscriber's line. This ringing current is applied intermittently in a well known manner until the called subscriber removes his receiver from the hook, thereby causing an increase in the current flowing in the upper winding of relay 407, whereupon this relay again operates thereby disconnecting the ringing current and again locking the relay to ground over the control conductor 441, it being assumed that the toll operator has restored the ringing key at the toll office, thereby releasing relays 369 and 332, and reconnecting ground at contacts 331 of relay 332 to this control circuit. It will, of course, be evident that only a short pulse of ringing current is necessary to cause the initial release of relay 407, after which the ringing is continued automatically from the connector circuit until the called subscriber answers and causes the reoperation of relay 407. It will be noted that the dialing key 107 can be restored at any time after the dial has once been moved off normal, thus causing the closure of a locking circuit for relay 106.

The extension of the tip and ring conductors of the trunk to the subscriber's line by the operation of relay 407, when the called station S answers, operates relay 344 over a circuit including the windings of coil 342, contacts of relay 329 and the right-hand windings of repeating coil 312. Talking current is fed to the calling subscriber's line at the distant exchange in which the toll line 121 terminates. When relay 344 operates it closes an obvious circuit for the energization of relay 309. Relay 309, in operating, supplies at its alternate contacts 370 ground for holding relay 407 locked, which circuit can

be traced as follows: battery, lower winding and contacts 410 of relay 407, conductors 441, terminal 364 (Fig. 3), brush 350, contacts 349 of relay 319, conductor 327, contacts 328 of relay 329 and to ground over contacts 370 of relay 309. Relay 309, in operating, opens at its contacts 308 the loop circuit containing the relay 305, leading back to the toll office, thus causing the deenergization of the calling supervisory relay 118, which in releasing, extinguishes the supervisory lamp 119 which notifies the operator that the subscriber has responded. By moving the switchhook up and down the subscriber at station S can cause the supervisory lamp 119 in the toll cord to flash as is the manual practice for releasing the switches. This is apparent from the following description inasmuch as the relay 344 is in circuit with the called subscriber's line and each time it attracts its armature relay 309 is energized which breaks the circuit leading back to the supervisory relay 118 and at the same time places a bridge including resistance 371 and contacts 306 of relay 307 across relay 305 to hold it operated, thereby preventing release of the switches.

The operator can re-ring the called subscriber after he has replaced his receiver by actuating the ringing key 120 thereby operating relay 369, which in turn, operates relay 332. When relay 332 attracts its upper inner armature, ground is disconnected from the control lead 441 (Fig. 4), thereby permitting relay 407 to release and to connect ringing current to the subscriber's line as before described. When the conversation is finished and the subscriber at station S has replaced his receiver, supervisory lamp 119 lights as is the manual telephone practice, which is a signal for the operator to take down the connection and the plug 100 is removed from the jack 200. Relay 305 (Fig. 2) is released which causes the restoration of all the switches to normal as will be described later.

If, however, the operator removes the plug from the trunk jack while the subscriber at station S has the receiver off the hook, relay 305 which controls the release of the switches is maintained energized over the circuit including resistance 371, due to the operated condition of relay 344.

If in building up a connection the toll transmission selector (Fig. 3) encounters a busy trunk group leading to the connector (Fig. 4), a circuit change is brought about to flash the supervisory lamp 119 at a rate different from that caused by finding the desired line busy which will now be described more in detail.

In the case above described of all trunks between the toll transmission selector and the connector being busy, switch 337 would have been operated upon the movement of the selector to its eleventh secondary position, thereby closing a circuit for relay 359 which can be traced as follows: grounded battery, winding of relay 359, contacts 372 of relay 337 and over conductor 373 of relay 305 to ground.

Relay 359 in operating closes an obvious energizing circuit for relay 311 which in operating reverses and reduces the current going back to the pulse translating equipment of Fig. 2 and also applies ground to conductor 222 as before described in connection with the busy subscriber's line.

Relay 359 in operating also connects ground through interrupter 373 to operate relay 309 which relay is alternately operated and released in step with the interrupter and flashes the supervisory lamp 119 as before described, the only difference being that interrupter 373 is arranged to break the circuit of relay 309 at the rate of sixty instead of one hundred and twenty times per minute as was the case with interrupter 358 which was employed in the case of the line busy condition.

The operator in receiving such a paths busy signal disconnects as before described and the switches return to normal.

It will now be assumed that the called subscriber's line was reached and found idle and the called subscriber answered the call and at the completion of the conversation hung up his receiver, whereupon the supervisory lamp 119 was steadily lighted as a signal to the operator that the called subscriber had finished. It will further be assumed that upon receiving this signal the operator removes the plug 100 from the jack 200 for the purpose of breaking down the connection. Under these conditions relay 305 will release, which, in turn, will release relay 314. Relay 314, in releasing, opens at its other left armature contacts the ground connection for the sleeve conductor 315 leading back over the contacts of switch 210, winding of relay 213, normal contacts of the rotary magnet SM, contacts of the off-normal switch 231 and winding the marginal relay 232, whereupon relay 213 releases and closes the circuit for the release magnet 233, the circuit for which can be traced from grounded battery, winding of release magnet 233, contacts 234 of switch 231, contacts 235 of relay 236, contacts 237 of relay 209 and normal contacts 238 of relay 213 to ground. The removal of ground from conductor 340 by the release of relay 314 releases relay 319. Relay 314 in releasing also closes its contacts 375 which completes an energizing circuit for the release magnet 374, which can be traced from grounded battery, winding of magnet 374, contacts 376 of switch 323, contacts 375 of relay 314 and contacts 377 of relay 305 to ground. Relay 307 is energized in parallel with magnet 374

and opens at its right-hand normal contacts the circuit for test brush 341 through the restoration operation. Relay 307 when energized also locks itself up at its left-hand alternate contacts in a circuit including the contacts 376 of the switch 323, which switch will be opened when the selector is restored to normal.

The removal of ground from the test brush 341 causes relay 402 to release, which in turn causes relay 400 to release, which relay in retracting its lower armature completes a circuit for release magnet 417 which can be traced from grounded battery through the winding of magnet 417, contacts 443 of switch 415, contacts 444 of relay 407, contacts 412 of relay 400 and contacts 409 of relay 402 to ground. When the connector in restoring reaches its normal position switch 415 is opened.

When the toll transmission selector switch (Fig. 3) returns to normal, switch 323 is open thereby removing ground at its contacts 368 to release relay 311 which relay in releasing romoves ground from conductors 361 and 222, thereby causing the deenergization of relay 203, which relay in releasing disconnects the jack from the trunk conductors 226 and 230 and reconnects relay 202 across the tip and ring springs of the jack.

It will be observed that throughout the building up of the connection, battery was supplied from the dial 109 of the cord circuit for operating the pulse translating relay 202 at the machine switching office, which relay in turn controlled the usual pulsing circuit and that when the dial was standing in its normal position, the trunk between the toll office and the machine switching office was "dry," that is, free from battery.

What is claimed is:

1. In a telephone system, an operator's position, a trunk circuit extending therefrom to an automatic exchange and having normally no connections to battery or ground, a cord circuit at said operator's position for connecting with said trunk circuit, a sender circuit including a source of dialing current adapted to be switched into connection with said cord circuit to transmit current pulses over said trunk circuit from said source corresponding to the desired setting of a switch in said automatic exchange, and means in said trunk circuit at the automatic exchange end thereof responsive to said pulses to control the setting of said switch.

2. In a telephone system, an operator's position, a normally dry trunk circuit extending therefrom to an automatic exchange, subscribers' lines terminating in said exchange accessible to said trunk circuit, a cord circuit at said operator's position for connecting with said trunk circuit, a sender circuit including a source of dialing current adapted to be switched into connection with said cord circuit to transmit current pulses from said source over said trunk circuit corresponding to the desired setting of a switch at said automatic exchange for connecting said trunk circuit with one of said subscribers' lines, means including a relay, associated with said trunk circuit at said automatic exchange responsive to said pulses to control the setting of said switch, and means for disconnecting said relay from said trunk circuit when the desired subscriber's line is seized by said switch.

3. In a telephone system, an operator's position, a normally dry interoffice trunk circuit extending therefrom to an automatic exchange, an automatic switch thereat accessible to said trunk circuit, a plurality of other trunk circuits extending from said automatic switch to certain other switches, a cord circuit at said operator's position for connecting with said interoffice trunk circuit, a sender circuit including a source of dialing current adapted to be switched into connection with said cord circuit to transmit current pulses over said interoffice trunk circuit corresponding to the desired setting of said first mentioned switch for connecting said interoffice trunk circuit with one of said plurality of other trunk lines, means including a relay associated with said interoffice trunk circuit at said automatic exchange responsive to said pulses to control the setting of said switch into engagement with one of said plurality of other trunks, and means for disconnecting said relay from said interoffice trunk when all of said plurality of other trunks are found busy by said first mentioned switch.

4. A telephone system, an operator's position, a normally dry trunk circuit extending therefrom to an automatic exchange, subscribers' lines terminating in said exchange accessible to said trunk circuit, a cord circuit at said operator's position for connecting with said trunk circuit, an operator controlled sender circuit including a source of dialing current adapted to be switched into connection with said cord circuit for transmitting current impulses from said source over said trunk circuit corresponding to the desired setting of a switch at said automatic exchange for connecting said trunk circuit to one of said subscribers' lines, means including a relay associated with said trunk circuit at said automatic exchange responsive to said pulses to control the setting of said switch, a signal device associated with said cord circuit, and automatic means for disconnecting said relay from said trunk, connecting said trunk with said automatic switch, disconnecting said dial from said cord circuit and for actuating said signal device when the desired subscriber's line is seized or when an intermediate paths busy condition is encountered.

5. A telephone system, an operator's position, a normally dry trunk circuit extending therefrom to an automatic exchange, subscribers' lines terminating in said exchange accessible to said trunk circuit, a cord circuit at said operator's position for connecting with said trunk circuit, an operator controlled sender circuit including a source of dialing current adapted to be switched into connection with said cord circuit for transmitting current impulses from said source over said trunk circuit corresponding to the desired setting of a switch at said automatic exchange for connecting said trunk circuit to one of said subscribers' lines, means including a relay associated with said trunk circuit at said automatic exchange responsive to said pulses to control the setting of said switch, a signaling device associated with said cord circuit, and automatic means for disconnecting said relay from said trunk, connecting said trunk with said automatic switch, disconnecting said dial from said cord circuit and for actuating said signaling device in one manner when an intermediate paths busy condition is encountered, in another manner if the desired subscriber's line is found busy and in a third manner when the desired subscriber's line is seized.

6. In a telephone system, an operator's position, a trunk circuit extending therefrom to an automatic exchange and having normally no connections to battery or ground, an operator's dial circuit including a source of current adapted to be connected to said trunk to transmit pulses of current thereover from said source, and a relay at said exchange associated with said trunk circuit and controlled by said pulses to in turn control the operation of a selector switch at said exchange.

7. In a telephone system, an operator's position, a trunk circuit extending therefrom to an automatic exchange, an operator's dial circuit including a source of current adapted to be connected to said trunk to transmit pulses of current thereover from said source, a selector switch at said automatic exchange associated with said trunk, a relay at said exchange associated with said trunk circuit and controlled by said pulses to in turn control the operation of said selector switch at said exchange, subscribers' lines accessible by said selector switch and for the establishing of a connection between a called subscriber and said trunk circuit, and means controlled by said switch when it comes to rest on a called subscriber's line for disconnecting said relay from said trunk circuit.

In testimony whereof, I have signed my name to this specification this 10th day of June, 1924.

JOHN F. TOOMEY.