

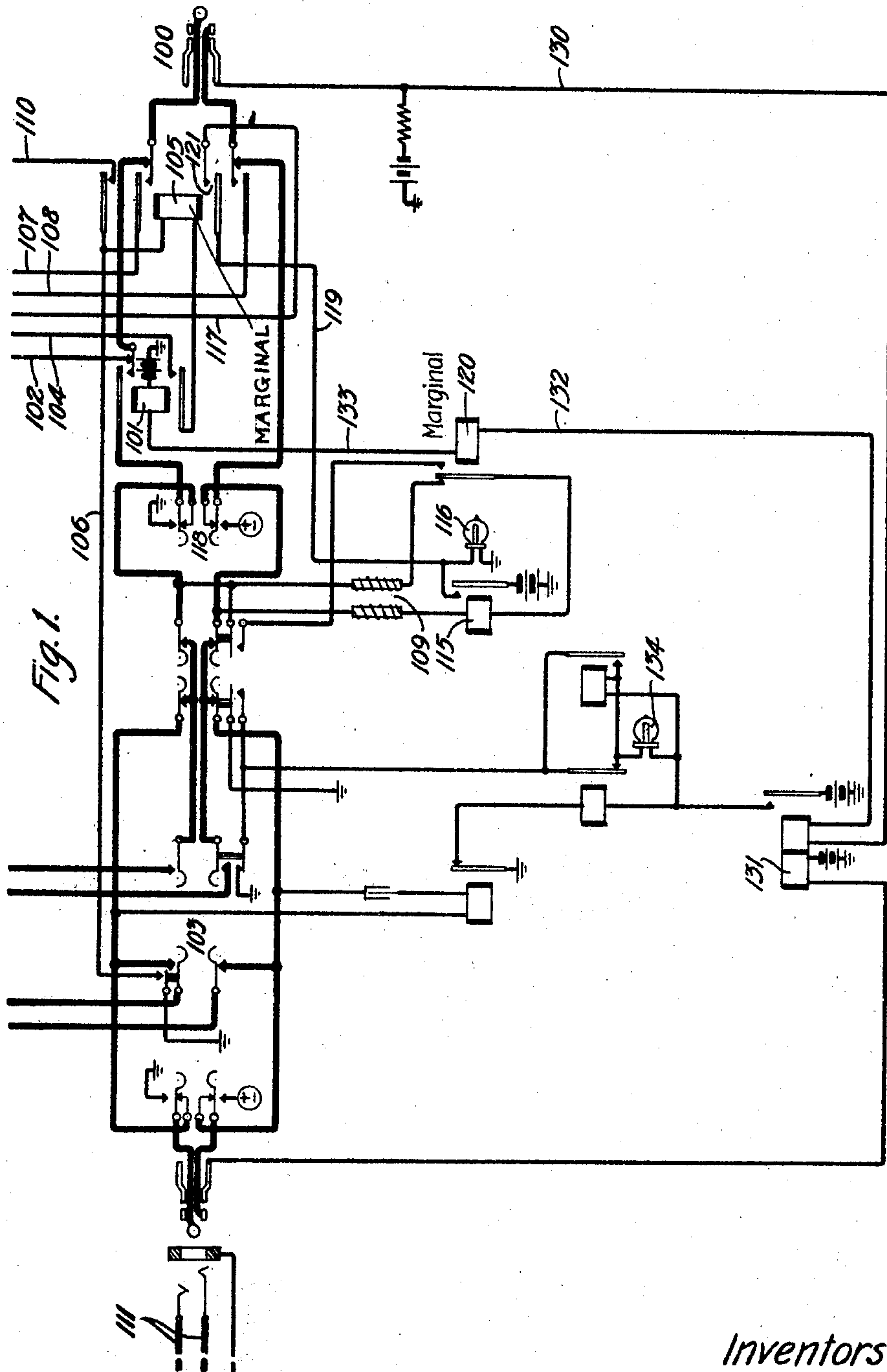
Nov. 24, 1925.

1,562,526

J. F. TOOMEY ET AL
TELEPHONE EXCHANGE SYSTEM

Filed Aug. 16, 1923

5 Sheets-Sheet 1



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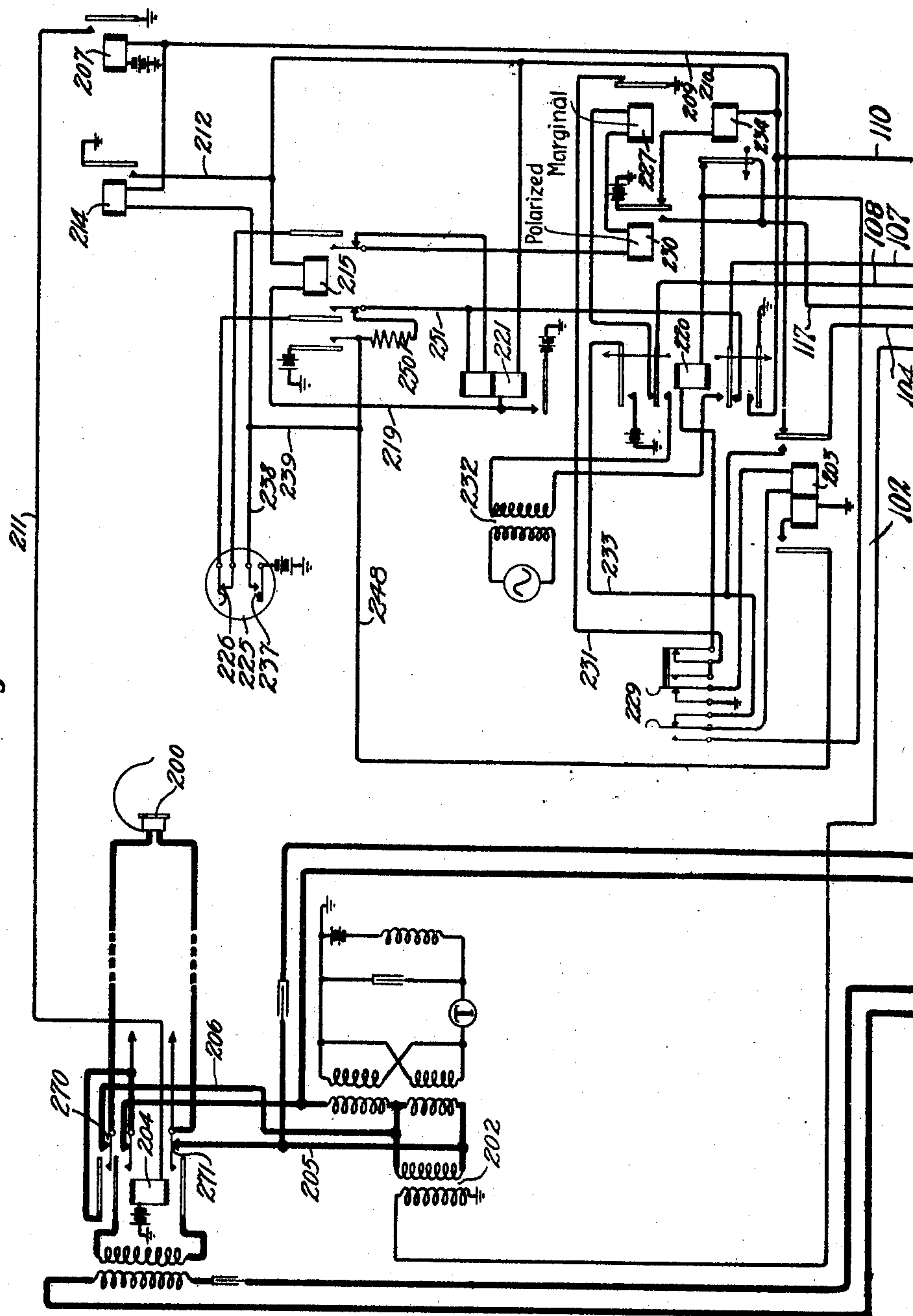
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TELEPHONE EXCHANGE SYSTEM

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5 Sheets-Sheet 2

Fig. 2.



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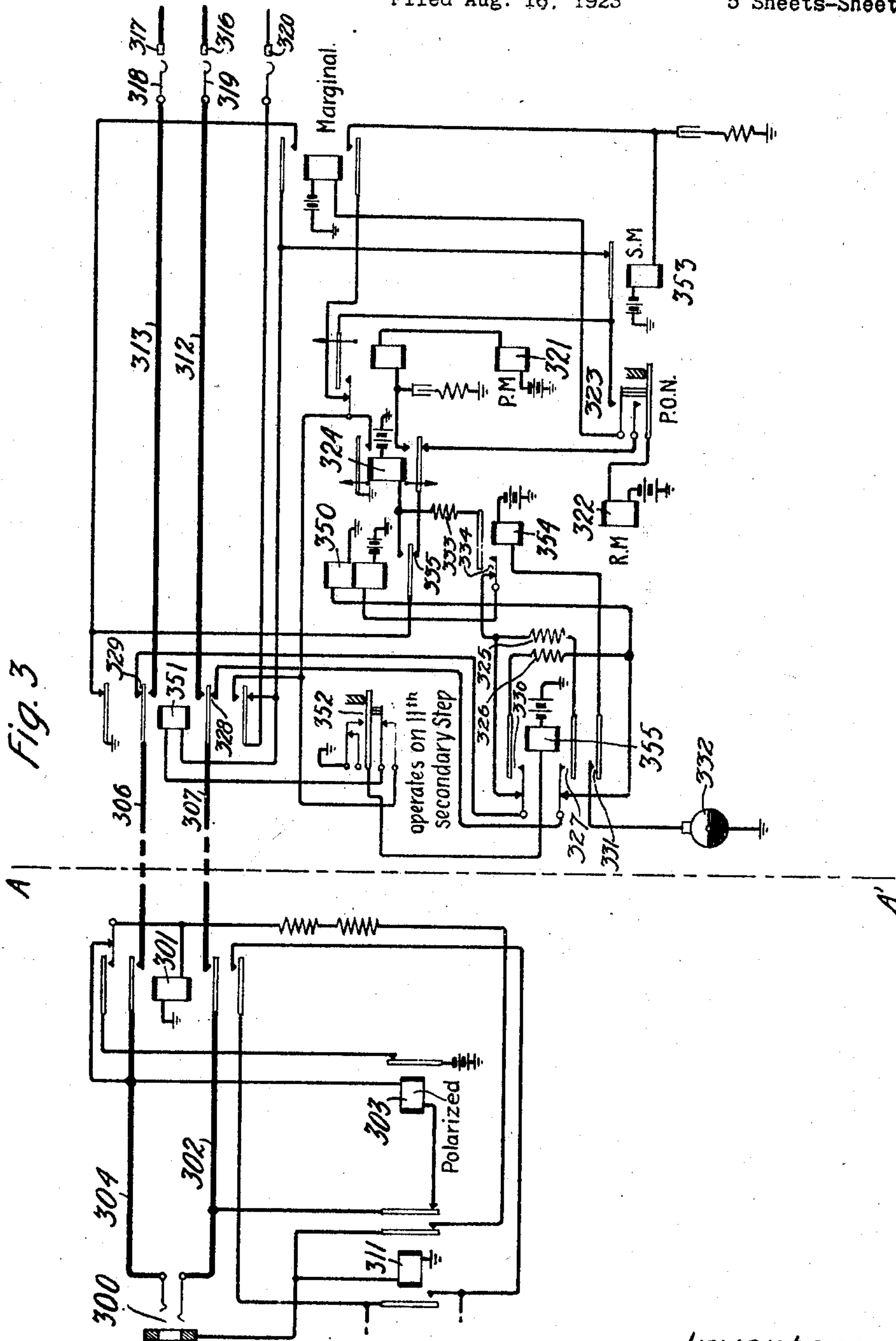
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5 Sheets-Sheet 3



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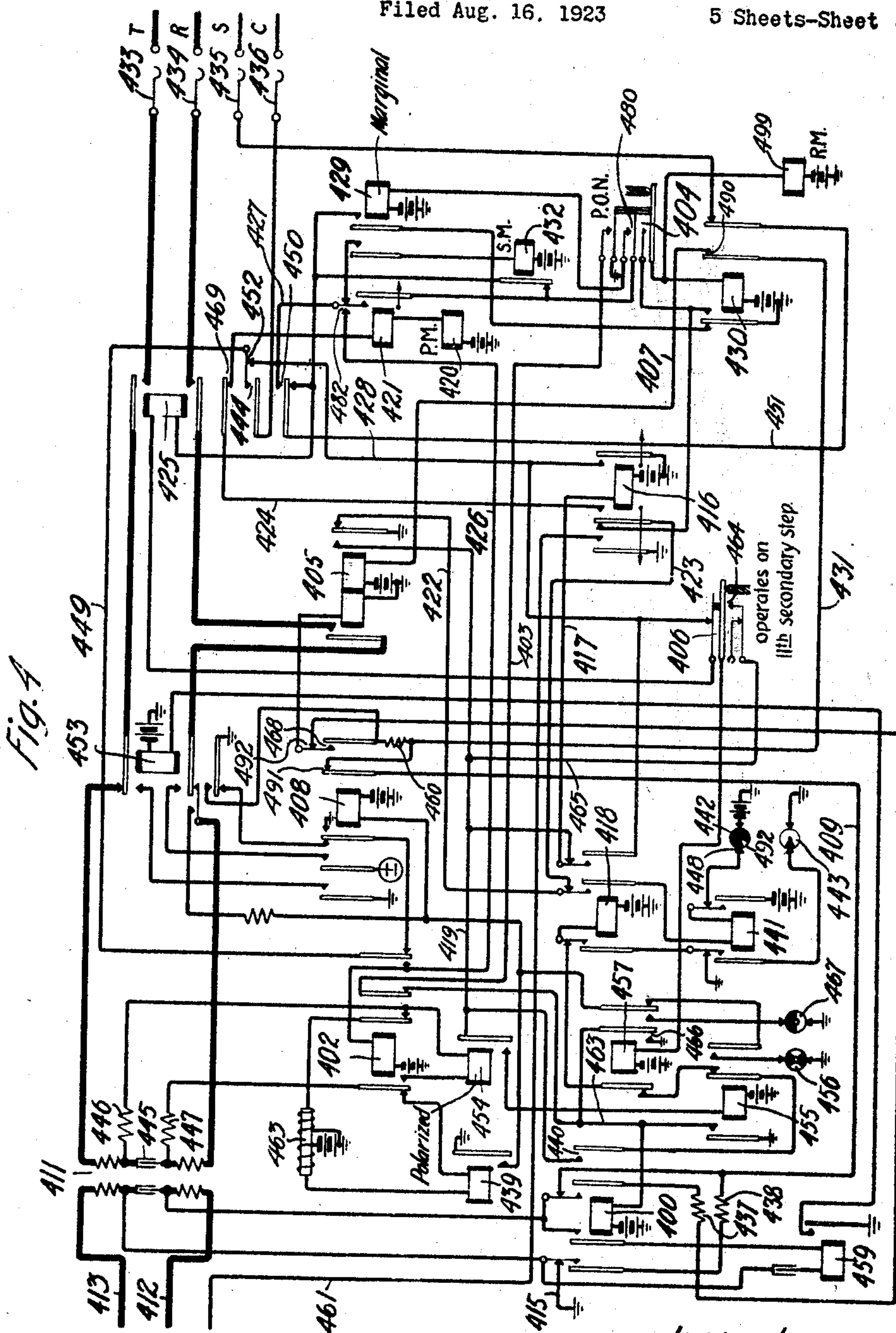
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J. F. TOOMEY ET AL

TELEPHONE EXCHANGE SYSTEM

Filed Aug. 16, 1923

5 Sheets-Sheet 4



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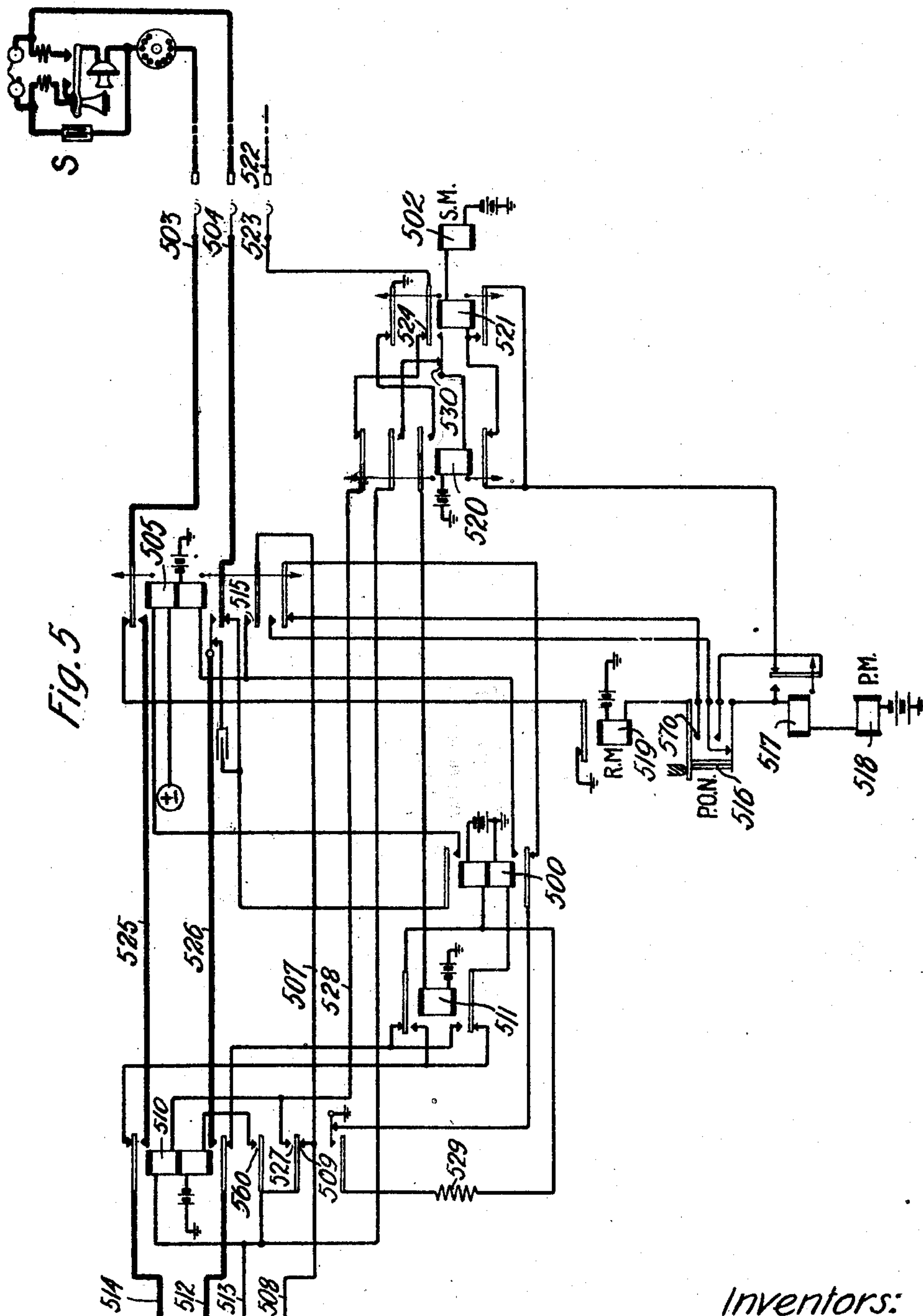
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J. F. TOOMEY ET AL
TELEPHONE EXCHANGE SYSTEM

Filed Aug. 16, 1923

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE.

JOHN F. TOOMEY AND HENRY E. PHELPS, OF NEW YORK, N. Y., ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed August 16, 1923. Serial No. 657,756.

To all whom it may concern:

Be it known that we, JOHN F. TOOMEY and HENRY E. PHELPS, residing at New York and New York, in the counties of New York and Bronx and State of New York and New York, respectively, have invented certain Improvements in Telephone-Exchange Systems, of which the following is a specification.

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

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

A feature of this invention is the provision of a circuit arrangement for toll cords wherein a dial and signaling equipment common to the toll position, is placed in operative relationship with the toll cord taken for use, by the combined actuation of a key individual to the cord and the movement of the dial off normal. The dialing key can be restored at any time thereafter without disturbing the dialing operation and the dial and signal equipment is freed only upon the completion of the normal dialing operation and the seizure of the called line or upon the disconnection of the cord from the trunk.

25 The circuit arrangement is also such that upon the seizure of the called line, a momentary pulse of the ringing current is automatically applied to the trunk at the toll office to initiate the usual machine ringing at the connector at the machine switching office.

40 Still another feature of the invention, related to the foregoing, is the provision of a circuit arrangement whereby the disconnection of the dialing equipment from the trunk upon the seizure of the called line is delayed, a sufficient length of time, to permit of the application of the before mentioned momentary ringing pulse for starting the machine ringing.

50 Another feature of the invention also related to the foregoing is the provision of a transformer for supplying the ringing current which is bridged across the trunk dur-

ing the ringing pulse interval. This bridge prevents the release of the automatic switches during the interval the before mentioned ringing pulse is being applied to the trunk.

Another related feature to the foregoing resides in the provision of means whereby the automatic initiation of ringing is prevented in case a busy subscriber's line is encountered.

A further feature of the invention is the provision of an improved circuit arrangement at the machine switching office for permitting the toll operator to change cords without causing the release of the mechanical switches at the machine switching office. This arrangement is effective only after the subscriber's line has been reached and when the receiver is on the hook.

Another related feature is the provision of means whereby the outgoing trunk is caused to test busy to other operators during the delayed release interval.

Other features will appear hereinafter.

Referring to the drawings, Figure 1 shows a toll cord circuit;

Fig. 2 shows an operator's telephone circuit and associated dialing equipment;

Fig. 3 shows, at the left of the broken line A—A' an outgoing trunk circuit to a machine switching office, and to the right of the line A—A' an incoming selector at the machine switching office;

Fig. 4 shows a toll transmission selector and,

Fig. 5 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 a telephone and dialing circuit shown in Fig. 2 which is common to these toll cords. When the operator desires to build up a toll connection, she inserts the plug 100 into the jack 300 of an idle outgoing automatic toll switching trunk leading to the desired machine switching office and actuates the dialing and monitoring key 103 of the toll cord taken for use. This key when operated prepares a circuit for a relay 105 in the toll cord which operates when the dial is moved off normal and disconnects the calling plug 100 from the nor-

- mal bridge across the cord including the supervisory relay 115 and the impedance coils 109 and connects the common dialing circuit shown in Fig. 2 to the calling plug.
- Relay 105 locks up in series with relay 214 and the dialing equipment is locked to the trunk independent of the condition of the dial or dialing key, but is held under control of relay 101 which will release to open this circuit and disconnect the dialing equipment in case the plug is removed. The operator then continues rotating the dial 225 in accordance with the digits of the desired number.
- If the incoming toll selector, Fig. 3, encounters a busy trunk group switch 352 is operated by the 11th rotary step of the selector, thus causing the operation of relay 355 which reverses and reduces the current flowing back to the toll office. Relay 355 also connects interrupter 332, operating at 60 interruptions per minute, to relay 354, which relay is caused to interrupt the current flowing back to the toll office in step with the interrupter, where it causes relay 230 to flash the lamp 116 at the same rate.
- If a busy condition is encountered at the toll transmission selector, Fig. 4, switch 403 will operate relay 457 upon the movement of the selector to its 11th rotary position, thereby energizing relay 400 and causing it to reverse and reduce the current flowing back to the toll office as before. Relay 457 in operating also connects interrupter 467 (which also operates at 60 interruptions per minute) to relay 408 which, in following the interrupter, interrupts the current now flowing back to the toll office where it causes relay 230 to flash lamp 116 as before.
- The operator upon noticing the flashing of lamp 116 disconnects in the usual manner and the switches return to normal. The reduction of the current in the above two cases causes relay 227 to release but this has no effect at this time as slow relay 234 does not have time to release due to the rapid operation of relay 230.
- If the connector finds the subscriber's line busy, relay 511 will operate to reverse the current flowing back to the toll transmission selector where it operates polar relay 454, which in turn, causes relay 400 to operate, which reverses and reduces the current flowing in the loop circuit leading back to the toll office where this reversed current operates polar relay 230. Relay 454 also causes the relay 408 to intermittently open and close this loop circuit at a rate of 120 per minute in step with interrupter 456. Polar relay 230, when operated, connects battery at its alternate contact to light supervisory lamp 116 which flashes in unison with the opening and closing of the loop circuit at relay 408. The reduction of the current caused by the operation of relay 400, causes relay 227 to release, but this has no effect at this time as slow relay 234 does not have a chance to release due to the rapid operation of polar relay 230 in step with interrupter 456.
- If the subscriber's line is idle it is seized by the connector and relay 400 again reverses and reduces the current flowing back to the toll office where it operates polar relay 230 and releases relay 227. Relay 230, in operating at this time connects battery to steadily light supervisory lamp 116 to indicate to the operator that the subscriber's line has been seized and also causes, in conjunction with relay 227 (now deenergized), the operation and subsequent immediate release of relay 220, which causes, during its operated period, a single short pulse of ringing current to be applied to the trunk which results in the connection of intermittent ringing current to the subscriber's line at relay 505 of the connector, which ringing persists until the receiver at the called station is removed from the hook.
- When relay 220 releases after sending out the pulse of ringing current it brings about the release of relay 105 thereby automatically disconnecting the dialing equipment from the cord.
- It will be noted that the dialing equipment is locked to the cord when the dial is moved off normal in a circuit independent of the dialing key or the dial and will only be disconnected therefrom after the complete number is dialed and an idle subscriber's line seized or by the manual act of removing the plug from the jack.
- In case the operator desires to change cords while the called subscriber's receiver is on the hook, the removal of the plug from the jack releases relay 405 which would have the effect of deenergizing relay 416, thereby initiating the release of the switches except for the fact that relay 418, which, when operated, provides a holding circuit for relay 416, is held energized by rotating cam 443 for approximately three seconds which is sufficient to enable the operator to change cords.
- 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 the jack 300 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 300 which produces a click in the receiver 200 of the operator's headset in the following manner: battery from

the sleeve, over the tip of the plug 100, upper normal contacts of relays 105 and 101, conductor 102 and primary of induction coil 202 to ground. Current in this circuit produces a click in the receiver 200 due to the flow of induced current in the circuit comprising the secondary winding of induction coil 202, conductors 205 and 206, normal contacts 270 and 271 of relay 204 and the winding of receiver 200. The insertion of the plug in the jack closes a circuit for the operation of the busy test relay 101 and relay 131 which may be traced from battery, relay 101, conductor 133, marginal relay 120, conductor 132, right-hand low resistance winding of relay 131, conductor 130, sleeve contacts of the plug 100 and jack 300, and sleeve relay 311 to ground. Relays 101, 131 and 311 now operate but marginal relay 120 does not operate at this time.

Relay 101, in operating, disconnects the busy test conductor 102 from the tip of the cord and extends the tip to a normally closed contact of the ringing key 118. Relay 131, in operating, prepares a circuit for lamp 134 to light in response to alternating current which may be applied to the cord by the distant toll operator over the toll line 111. As relay 120 does not operate at this time, relay 115 remains bridged across the toll cord in series with the impedance coils 109. Relay 311 in attracting its outer right armature opens a bridge, including relay 303, across the trunk conductors 302, 304 to prevent interference with the transmission of impulses.

The operator next actuates the monitoring and the dialing key 103 which closes a circuit from ground, alternate contact of key 103, over conductor 106, through marginal relay 105, lower contacts of relay 101, conductor 104, right normal contact of relay 203, conductor 209 and relay 207 to battery and ground. Relay 207 operates in this circuit but relay 105 being marginal does not operate at this time. Relay 207 on operating closes a circuit for the operation of the monitoring relay 204 which may be traced from battery, relay 204, conductor 211 and contact of relay 207 to ground. Relay 204 operates in this circuit, thus preparing the operator's head receiver circuit for monitoring.

It may be that at certain times, the operator will be requested to obtain connection with subscribers in manual offices as well as with subscribers in offices operating on an automatic basis. In such cases, the same cord is used and the operation of the monitoring key 103 will be the same as described above. The outgoing trunk with which the cord circuit is associated in this case will be of the usual manual type.

The operator now turns the dial 225 for the first digit of the wanted number. Bat-

tery is then connected over the off-normal contact 237 of the dial conductor 238 through the low resistance relay 214, conductor 209, right-hand normal contacts of relay 203, conductors 208 and 104, lower closed contact of relay 101, marginal relay 105, conductor 106, upper closed contacts of key 103 to ground, thereby shunting the relay 207 and causing an increase in the current flowing in marginal relay 105. Relays 105 and 214 now operate. Relay 214 closes at its contact a ground connection for the operation of relay 234, the circuit for which may be traced from battery, normal contact of relay 230, relay 234, conductors 210 and 212 to ground, at the closed contact of relay 214. Relay 105, in operating, connects the dialing circuit through to the trunk and opens up the cord circuit so that the relatively heavy dialing current used will not flow in the cord circuit and injure the low impedance coils 109 bridged across the cord. When relay 105 operates, it also completes the following circuit for relay 301 in the trunk circuit, Fig. 3: battery, off-normal contact of dial 225, conductors 238 and 239, resistance 250, inner normal contact of relay 215, conductor 251, inner lower normal contact of relay 220, conductor 107, upper inner alternate contacts of relay 105, tip contacts of plug 100 and jack 300, trunk conductor 304, upper normal contact of relay 301 and winding of that relay to ground. Relay 301 operates in this circuit and locks up through its contact in the following circuit: battery, normal contact of relay 303, and upper alternate contact and winding of relay 301 to ground. Relay 301 also connects the conductors 302 and 304 through to the line conductors 306 and 307.

As soon as the trunk conductors from the automatic office have been cut through to the toll office the bridged relay 221 in the dialing circuit draws current through the relay 350 in the toll selector circuit, Fig. 3, and both relays operate. This circuit may be traced as follows: ground, upper winding of relay 350, lower inner normal contacts of relay 355, lower inner normal contacts of relay 351, conductors 307 and 302, ring contacts of jack 300 and plug 100, lowermost alternate contacts of relay 105, conductor 108, inner, upper normal contacts of relay 220, winding of relays 227 and 230, right-hand normal contact of relay 215, upper winding of relay 221, conductor 251, inner and lower normal contact of relay 220, conductor 107, alternate contact of relay 105, tip contacts of plug 100 and jack 300, conductor 304, upper inner contacts of relay 301, conductor 306, upper inner normal contacts of relay 351, upper normal contacts of relays 355 and 354, and lower winding of relay 350 to battery. Relay 221 locks up in the following circuit: battery, alter-

nate contact and lower winding of relay 221 to ground at the alternate contact of relay 214. The operation of relay 221 closed a circuit for the operation of relay 215 which may be traced from battery, alternate contact of relay 221, conductor 219, winding of relay 215, conductor 212 to ground at the alternate contact of relay 214. Relay 215 in operating disconnects the upper winding of relay 221 from the trunk and substitutes therefor the closed dial pulsing contacts 226. Relay 215 in operating also connects battery direct to relay 214, thus making this relay independent of the battery supplied through the off-normal contact 237 of the dial, this circuit being traced from battery, left alternate contact of relay 215, conductor 239, winding of relay 214, over conductor 209, right normal contact of relay 203, conductors 208 and 104, lower alternate contacts of relay 101, winding of relay 105 and conductor 106 to ground at the upper contacts of key 103.

It will be observed that relay 214, now operated, holds ground at its right closed contact over conductors 212, 210, and 110, through the upper closed contact of relay 105 to the winding of relay 105 and therefore, relays 105 and 214 are locked up in series with each other in the following circuit: battery, left alternate contact of relay 215, conductors 239 and 238, winding of relay 214, over conductor 209, right normal contact of relay 203, conductor 104, lower contacts of relay 101, winding of relay 105 and its upper closed contact, conductors 110, 210 and 212 to ground at the contact of relay 214, and therefore the dialing equipment connected over conductors 107 and 108 is locked, under control of relay 101, to the trunk circuit at the armature contacts of relay 105, independent of the dial 225 or dialing key 103. Relay 101 will release to break this holding circuit upon the removal of the plug. The dialing equipment will also be automatically released when the dialing operation is completed.

The incoming selector circuit shown at the right of the broken line AA' in Fig. 3 functions in the well-known manner as described in Patent No. 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 magnet 321 of the selector receives impulses from the impulse relay 350 in the well-known manner and raises the selector brushes to the desired level, after which the rotary magnet 353 is energized and hunts for an idle trunk leading to the toll transmission selector, Fig. 4.

Upon the seizure of an idle trunk, relay 351 operates and cuts off the bridge containing the impulse relay 350 and extends the trunk conductors 307, 306 through to the toll

transmission selector, Fig. 4, whereupon the impulse relay 405 operates over the following circuit: battery, right winding of relay 405, conductor 407, contacts 490 of relay 430, conductor 431, contacts 491 of relay 408, conductor 409, inner right-hand normal contact of relay 400, lower left winding of repeating coil 411, conductor 412, multiple terminal 316, brush 319, conductor 312, lower inner alternate contact of relay 351, conductor 307, lower inner contacts of relay 301, conductor 302, ring contacts of jack 300 and plug 100, lower outer alternate contacts of relay 105, conductor 108, upper normal contact of relay 220, windings of relays 227 and 230, right alternate contact of relay 215, pulsing contact 226 of dial 225, inner left alternate contact of relay 215, conductor 251, lower normal contact of relay 220, conductor 107, upper alternate contact of relay 105, tip contacts of plug 100 and jack 300, conductor 304, upper inner contacts of relay 301, conductor 306, upper inner alternate contacts of relay 351, conductor 313, brush 318, multiple terminal 317, conductor 413, upper left-hand winding of repeating coil 411, left normal contact of relay 400, and conductor 415 to ground.

The impulse relay 405 in attracting its right armature energizes slow relay 416 in a circuit which can be traced from battery, winding of relay 416, conductor 417, outer right normal contact of relay 418, conductor 419, to ground at the right-hand alternate contact of relay 405. Slow relay 416 attracts its outer left armature and places ground on the test terminal 320 (Fig. 3) to cause this trunk to test busy in the well-known manner.

The second operation of the dial causes relay 405 to transmit impulses over the following circuit to the vertical magnet 420: ground, right normal contact of relay 405, conductor 422, inner right normal contact of relay 418, conductor 423, inner left alternate contact of relay 416, conductor 424, normal contact 469 of relay 425, winding of slow relay 421 and winding of vertical magnet 420 to battery. The brushes of the selector are thus elevated to the level in which trunks leading to the desired connector group terminate. When the dial returns to normal and maintains the relay 405 energized, slow relay 421 after a short interval releases.

When relay 421 operated on the first impulse and the selector took its first step, relay 429 operated in the following circuit: battery, winding of relay 429, closed contact 480 of PON switch 404, inner right alternate contact of relay 421, conductors 427 and 428 and to ground at the right alternate contact of relay 416. In attracting its inner armature relay 429 locks in a circuit including the back contact of rotary magnet 432. This circuit may be traced as follows: bat-

tery, winding of relay 429, alternate contact 480 of PON switch 404, normal contact of rotary magnet 432, inner alternate contact of relay 429, to ground at the left normal contact of relay 430. Relay 429, in operating, also closes a shunt circuit around relay 425 which may be traced as follows: ground at the left normal contact of relay 430, inner alternate contact of relay 429, through the winding of relay 425, upper normal contact of switch 406 and to ground again at the right alternate contact of relay 416. Upon the cessation of the impulses and the release of the slow relay 421, the circuit of the rotary magnet is closed as follows: battery, winding of rotary magnet 432, outer alternate contact of relay 429, normal contact of relay 421, conductors 427 and 428, to ground at the right alternate contact of relay 416. The rotary magnet advances the brushes to the terminals of the first trunk and if it is not busy, the sleeve terminal will not be grounded and the locking circuit of relay 429 is opened at the armature contact of rotary magnet 432 and relay 429 releases, thus removing the shunt around relay 425 which was applied when relay 429 operated, and opening the circuit of rotary magnet 432. When the armature of rotary magnet 432 retracts it closes a circuit for the operation of relay 425 which can be traced as follows: battery, winding of relay 429, contact 480 of PON switch 404, normal contact of rotary magnet 432, winding of relay 425, normal contact of switch 406 and to ground at the right alternate contact of relay 416. Relay 425 energizes in this circuit, but relay 429 due to its adjustment cannot operate in series with relay 425.

If the first trunk is busy its sleeve contact will be grounded. In this case relay 429 releases as usual but relay 425 will not operate as it is now shunted through the outer right normal contact of relay 430 and the sleeve brush 435 to ground, instead of through the inner alternate contact of relay 429. When the rotary magnet 432 releases, relay 429 again energizes which in turn causes magnet 432 to operate and the brushes are stepped to a second set of terminals. This operation is continued until an idle trunk is found.

Relay 425, in operating, when an idle trunk is reached, extends the tip and ring conductors of the trunk through to the brushes 433 and 434 which are now in engagement with an idle connector. Relay 425, in operating, also grounds the sleeve brush 435 and consequently the test multiples of the selected trunk thereby causing them to test busy to other selectors. This circuit may be traced as follows: ground, right alternate contact of relay 416, conductor 428, lower alternate contact of relay 425, outer right normal contact of relay 430,

sleeve brush 435 and the test terminal of the selected trunk. Relay 425 also opens the circuit of the vertical magnet 420.

When vertical magnet 420 was first actuated, relay 402 was operated over the following circuit: ground, right alternate contact of relay 416, conductor 428, 427, contacts 482 of relay 421, conductor 426, winding of relay 402 to battery. Relay 402, in operating, locks itself up in the following circuit: battery, winding and outer right alternate contact of relay 402, conductor 449, normal contact 452 of relay 425, conductor 428 to ground at the right alternate contact of relay 416. Relay 402, in operating, opens the circuit of relays 439 and 400 and shunts the condenser 445 through resistances 446, 447 and polar relay 454 so that the pulsing relay 500 (Fig. 5) will operate when the connection is extended to the connector.

When relay 425 operated it closed its alternate contact 444 before it opened the normal contact 452 so that relay 402 is maintained locked in a circuit which now can be traced as follows: battery, winding and outer alternate contact of relay 402, conductor 449, alternate contact 444 of relay 425, brush 436, conductor 508 (Fig. 5), normal contact 509 of relay 510, conductor 513, brush 435, Fig. 4, outer right normal contact of relay 430, conductor 451, alternate contact 450 of relay 425, conductor 428, to ground at the right alternate contact of relay 416. Thus the circuit of relay 402 will be maintained closed as the circuit is extended, for a purpose which will later appear.

The seizure of the trunk to the connector (Fig. 5) closes the following circuit for the pulsing relay 500: battery, upper winding of relay 500, upper normal contact of relay 511, inner lower normal contact of relay 510, ring conductor 512, brush 434, inner lower alternate contact of relay 425, left alternate contact of relay 405, inner lower normal contact of relay 453, lower right-hand winding of repeating coil 411, resistance 447, left alternate contact of relay 402, winding of relay 454, resistance 446, upper right-hand winding of repeating coil 411, upper normal contacts of relay 453, upper contacts of relay 425, brush 433, tip conductor 514 (Fig. 5), upper normal contact of relay 510, lower normal contact of relay 511 and lower winding of relay 500 to ground. Relay 500 is energized in this circuit and closes a circuit for the energization of relay 505 which can be traced as follows: battery, lower winding of relay 505, lower alternate contact of relay 500, to ground at the lowermost normal contact of relay 510. Relay 505 operates and locks up to the sleeve conductor 513 which is grounded at relay 416 (Fig. 4). This circuit can be traced as follows: battery, lower winding and alternate contact

515 of relay 505, conductor 507, normal contact 509 of relay 510, conductor 513, brush 435 (Fig. 4), outer right normal contact of relay 430, conductor 451, alternate contact 450 of relay 425, conductor 428 and to ground at the right alternate contact of relay 416.

The return of the dial to normal in transmitting the tens digit of the wanted number interrupts the circuit of relay 500 at the left armature contact of relay 405. The armature of relay 500 follows the dial pulses and, in turn, transmits impulses to the vertical magnet 518 of the connector, the circuit of the first impulse being as follows: ground at the lowermost normal contact of relay 510, lower normal contact of relay 500, alternate contact of the lowermost armature of relay 505, normal contact of PON switch 516, winding of slow relay 517 and winding of vertical magnet 518 to battery. The PON switch 516 is operated on the first vertical step of magnet 518 thereby switching the impulse circuit from its normal to its alternate contact and over the alternate contact of slow-to-release relay 517 which was operated on the first impulse. Switch 516 also prepares a circuit for the operation of release magnet 519.

After the last impulse of the series, the brushes will have been elevated to the desired level and relay 517 deenergizes and switches the pulsing circuit to the rotary magnet 502 which can be traced as follows: ground at the lowermost normal contact of relay 510, lower normal contact of relay 500, lower alternate contact of relay 505, alternate contact of switch 516, normal contact of relay 517, lower normal contact of slow relay 520, winding of slow relay 521 and winding of rotary magnet 502 to battery.

As the last series of impulses comes in, the lower armature of relay 500 drops back in step therewith and moves the brushes 503 and 504 of the connector switch into engagement with the desired subscriber's line. When relay 521 operated it transferred the pulsing circuit from the normal contact of relay 520 to the lower alternate contact of relay 521.

As soon as slow-to-release relay 521 released, if the called line is idle, it closed a circuit at its inside upper normal contact for the operation of relay 510 which may be traced as follows: battery (not shown), sleeve contact 522 of the called line, brush 523, contact 524 of relay 521, upper normal contact of relay 520, upper winding of relay 510, conductor 513, terminal S (Fig. 4), brush 435, outer right normal contact of relay 430, conductor 451, lower alternate contact 450 of relay 425, conductor 428 and to ground at the right contacts of relay 416. Relay 510 operates in this circuit and locks

to ground on the sleeve conductor 513 in the following circuit: battery, lower winding and alternate contact 560 of relay 510, conductor 513, sleeve terminal S (Fig. 4), outer right normal contact of relay 430, conductor 451, lower alternate contact 450 of relay 425, conductor 428 and to ground at the right alternate contact of relay 416. Relay 510 in operating also connects the line conductors 514 and 512, through to conductors 525 and 526, respectively, and places ground on the multiple test terminal of the seized line over the following circuit: ground, right-hand contacts of relay 416, conductor 428, contacts 450 of relay 425, conductor 451, outer right-hand contacts of relay 430, brush 435, terminal S, conductor 513 (Fig. 5), contacts 527 of relay 510, conductor 528, upper normal contact of relay 520, contacts 524 of relay 521, brush 513 and test terminal 522 of the called subscriber's line. Further, relay 510 in attracting its lowermost armature removes ground from the lower armature of relay 500 and transfers it through resistance 529 to hold relay 500 operated during the continuance of the connection in order that the ringing current circuit which extends through the upper alternate contact of relay 500 will not be broken at this point.

If the called line is found busy, ground will be present on the test terminal 522 and before slow relay 521 has time to release, relay 520, which is also slow to release, will be energized thus breaking the pulsing circuit branch through its lower armature contact. When relay 521 finally releases, relay 520 locks up to ground on sleeve conductor 513 in the following circuit: battery, winding of relay 520, contact 530 of relay 521, upper middle contacts of relay 520, conductor 513, sleeve terminal S (Fig. 4), brush 435, right normal contact of relay 430, conductor 451, alternate contact 450 of relay 425, conductor 428 and to ground at the right alternate contact of relay 416. Relay 520, in operating, also connects ground to operate the reverse relay 511, the circuit of which may be traced as follows: ground, upper outer contacts of relay 521, upper inner contacts of operated relay 520, and winding of relay 511 to battery. Relay 511 now operates and reverses the current flowing back to the toll transmission selector (Fig. 4) where it operates the polar relay 454 bridged at the center of the right winding of repeating coil 411 in series with resistances 446 and 447. Polar relay 454, in operating, closes a circuit for relay 455 which may be traced as follows: battery, winding of relay 455, and contacts of relay 454 to ground at the right alternate contact of relay 405. Relay 455, in attracting its left-hand armature, closes an obvious energizing circuit for relay 400 which now operates and reverses and reduces the current in the loop

circuit leading back to the toll office. Relay 455 in attracting its outer right-hand armature connects an interrupter 456 in circuit with relay 408, this circuit including the outer right normal contacts of relay 457. Relay 408 at its contacts 491 and 492 intermittently opens both sides of the loop circuit leading back to the toll office. This intermittent opening and closing of the reversed and reduced current flowing in the loop circuit results in the intermittent operation of lamp 116 which preferably flashes at the rate of 120 flashes per minute in step with interrupter 456, thus indicating to the toll operator that the desired line is busy. The circuit for lamp 116 includes battery, alternate contact of relay 230, conductor 117, contacts 121 of relay 105, conductor 119 and ground at lamp 116. The operator recognizing this signal disconnects in the usual manner by removing plug 10 from jack 300 and the relay 105 connecting the dialing equipment to the cord is released due to the release of control relay 101 upon the opening of the sleeve circuit.

If the subscriber's line is not busy, it is seized and relay 510 operates as before described. Relay 510, in operating, opens at its armature contact 509 the holding circuit for relay 402, previously traced. Relay 402, therefore, releases and closes at its middle right-hand normal contact a circuit for the operation of relay 400 which may be traced as follows: battery, winding of relay 400, conductor 463, middle right-hand normal contacts of relay 402, conductor 403, and to ground at the upper contacts of switch 404.

When relay 402 releases it provides a substitute ground connection for the locking circuit of relay 505 so this relay will not de-energize when relay 510 is operated. This circuit may be traced as follows: battery, lower winding of relay 505, contacts 515 of relay 505, conductors 507 and 508, terminal C (Fig. 4), brush 436, contacts 444 of relay 425, conductors 449, outer normal contact of relay 402, inner left-hand normal contacts of relay 408, to ground at the lower normal contact of relay 453. Relay 400, in operating, in the circuit traced reverses the current flowing in the loop circuit back to the toll office, which loop includes the impulse relay 405. The current in this circuit is also reduced due to the insertion of resistances 437 and 438 in the loop when relay 400 operated. Due to the reversal of current in the loop circuit, polarized relay 230, Fig. 2, is operated at this time and marginal relay 227 releases due to the reduction of the current.

Relay 230, in operating, connects battery to operate the supervisory lamp 116, the circuit of which can be traced as follows: battery, alternate contact of relay 230, conductor 117, lower inner contacts of relay 105, con-

ductor 119, and ground through lamp 116 thus giving the operator an indication that the building up of the connection has progressed properly to the subscriber's line and would serve as a ringing signal except for the fact that ringing is done automatically, therefore making such a signal unnecessary. The ringing is started automatically in the following manner: When the polar relay 230 operated, it opened at its normal contact the energizing circuit for slow release relay 234, which in closing its normal contact causes the operation of relay 220 in the following circuit: battery, alternate contacts of relay 230, normal contacts of relay 234, winding of relay 220, right normal contact of key 229, and conductor 231 to ground at the normal contact of relay 227. Relay 220, in operating, connects ringing current, supplied through the transformer 232, to conductors 218, 224 and thence to the trunk conductors 302 and 304 extending to the office where it operates the alternating current relay 459 over an obvious circuit. Relay 459, in operating, closes at its contacts an obvious circuit for energizing relay 453. Relay 453 in operating breaks at its lower normal contact the locking circuit for relay 505 which relay now releases and applies ringing current over an obvious circuit to the subscriber's line through its upper winding. This ringing current is applied until the called subscriber removes his receiver from the hook thereby causing an increase in the current flowing in the upper winding of relay 505, whereupon it again operates, thereby disconnecting the ringing current and again locking up to ground on the control conductor 508.

When relay 220 operated it closed a circuit for the operation of relay 203 which may be traced as follows: battery, upper contacts of relay 220, conductor 233, left-hand normal contacts of key 229, right-hand winding of relay 203 and to ground at the inner right-hand normal contacts of key 229. Relay 203 in operating locks to relay 215 in the following circuit: ground, left-hand winding and alternate contact of relay 203, conductor 248 to battery at the outer left-hand contacts of relay 215. Relay 203 also opens at its right normal contact the energizing circuit for relay 214, which relay now releases. Relay 105, however, holds operated, as the lower alternate contact of relay 220, now operated, supplies ground to conductor 110 to replace the ground which is removed by the release of relay 214, and the upper contacts of relay 220 supply battery to replace that supplied at the left-hand contacts of relay 215 through relay 214. The holding circuit of relay 105 may be traced as follows: battery, upper contacts of relay 220, conductor 233, right-hand alternate contacts of relay 203, conductor 104, lower con-

tacts of relay 101, winding and upper outer contacts of relay 105, conductor 110 and to ground at the lower alternate contact of relay 220. The secondary winding of transformer 232 serves as a bridge across the loop circuit to hold operated the switches in the automatic office during the ringing period. When relay 220 operates, a circuit including polar relay 230 is opened at the upper and lower inner normal contacts of relay 220 thereby causing the release of relay 230 which closes at its normal or back contact a circuit for the re-operation of relay 234 in the following circuit: battery, normal contacts of relay 230, winding of relay 234, and to ground at the lower contacts of relay 220.

When relay 234 operates, it opens at its normal or back contact the energizing circuit for relay 220. Relay 220 is slow to release but soon opens its alternate contact and disconnects the ringing current from the cord.

It will be evident that only a single short pulse of ringing current has been automatically sent out, this being sufficient, however, to start the well-known machine ringing equipment at the automatic office, whereby the subscriber's station is rung until the receiver is removed as before described. When relay 220 released, it disconnected at its upper alternate contacts, the battery for holding relay 105 operated and this relay therefore released and disconnected at its upper and lower alternate contacts, the dialing equipment from the cord. The disconnection of ground at the lower alternate contact of relay 220 when that relay released, also caused the release of relays 234 and 221 and as a result, the dialing circuit returned to normal.

In case the operator still holds operated the dialing and monitoring key 103, relay 207 again operates and causes the monitoring equipment of the operator's set to function in the usual manner. It will be observed that at the end of the normal dialing operation, ringing is automatically started and the dialing equipment is automatically released independent of any act of the operator and therefore, she can take up other work such as answering other calls without interfering with the progress of the previous connection, as the trunk supervisory lamp 116 indicates to her the progress of the call, it having been lighted momentarily as a ringing signal when relay 230 is operated as previously described and later comes directly under control of the switches in the automatic office as soon as relay 105 releases at the end of the ringing pulse.

The extension of the tip and ring conductors of the trunk to the subscriber's line by the operation of relay 505 when the called station S answers, operates relay 439 over a circuit including the windings of coil 463,

contacts of relay 402 and the right-hand windings of repeating coil 411. Talking current is fed to the distant subscriber's line at the distant exchange in which the toll line 111 terminates.

When relay 439 operates, it closes a circuit for the energization of relay 408 which may be traced from battery, winding of relay 408 and to ground at the contacts of relay 439. Relay 408 in operating supplies at its inner left-hand alternate contact, ground for holding relay 505 locked, which circuit may be traced as follows: battery, lower winding and contacts 515 of relay 505, conductors 507 and 508, terminal C (Fig. 4), brush 436, contacts 444 of relay 425, conductor 449, outer right-hand normal contacts of relay 402 and to ground at the inner left alternate contacts of relay 408. Relay 408, in operating, opens at its right normal contacts the loop circuit containing the relay 405 and leading back on the toll office thus causing the deenergization of the calling supervisory relay 115 which in releasing extinguishes the supervisory lamp 116 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 116 in the toll cord (Fig. 1) to flash as in manual practice without releasing the switches. This is apparent from the foregoing description inasmuch as relay 439 is in circuit with the called subscriber's line and each time it attracts the armature, relay 408 is energized which breaks the circuit leading back to the supervisory relay 115 and at the same time places a bridge including resistance 460 and contacts 490 of relay 430 across relay 405 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 118 thereby operating relay 459 which in turn operates relay 453. When relay 453 attracts its lower armature, ground is disconnected from the control lead 508 (Fig. 5), thereby permitting relay 505 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 116 lights as in manual telephone practice which is a signal for operator to take down the connection. When the plug 100 is removed from the jack 300, relay 405, (Fig. 4) 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 his receiver off the hook, relay 405 which controls the release of the switches is maintained energized over the circuit including resistance 460 due to

the operated condition of relay 408. If in building up a connection the incoming toll selector, Fig. 3, or the toll transmission selector, Fig. 4, encountered a busy trunk group, a circuit change is brought about to flash the supervisory lamp 116 at a rate different from that caused by finding the desired line busy.

In the case of the incoming toll selector, Fig. 3, finding all trunks busy in the selected group leading to the toll transmission selector, switch 352 is operated on the eleventh step of the selector, thus closing an obvious energizing circuit for relay 355, which upon operating, reverses and reduces the current flowing back to the toll office in a similar manner to the operation of relay 400 previously described. The circuit for this reversed and reduced current can now be traced as follows: battery, lower winding of relay 350, contacts 334 of relay 354, resistance 325, contacts 327 of relay 355, contacts 328 of relay 351 and then over ring conductors 307 and 302 to the toll office in the before traced loop circuit where it passes through polarized relay 230, then returning over the tip conductors of the cord and trunk including 304 and 306, contact 329 of relay 351, contacts 330 of relay 355, resistance 326 and upper winding of relay 350 to ground. Other contacts 331 of relay 355 connect an interrupter 332, operating preferably at sixty interruptions per minute, to relay 354 causing this relay to operate intermittently in step with the interrupter. When relay 354 operates it connects ground over the upper normal contact of relay 351, the alternate contact of relay 350, and through resistance 333 to the lower winding of relay 350 to hold it operated and at the same time interrupts at its contacts 334 the flow of current to the toll office over the circuit just traced. In the dialing circuit at the toll office this interrupted reversed and reduced current operates polar relay 230 in step with the interrupter, which in turn, flashes lamp 116 in a circuit which can be traced from battery, alternate contact of relay 230, conductor 117, contacts 121 of relay 105, conductor 119 and lamp 116 to ground. As this busy signal occurs as soon as the trunk group is found busy, the operator can discontinue dialing and release the connection at once. Relay 234 is slow to release and holds up over the flashes thereby preventing the operation of ringing relay 220 at this time. When the operator disconnects, the pulsing relay 350 releases during the first interval that relay 354 is deenergized and the circuit for the release magnet 322 is closed at contacts 335, whereby the switch is returned to normal in the usual manner.

In case a busy condition was encountered at the toll transmission selector, Fig. 4, in-

stead of at the incoming toll selector, relay 457 would have operated upon the movement of the selector to its eleventh secondary position in the following circuit: battery, winding of relay 457, contacts 464 of switch 406, conductor 465 and to ground at the inside right alternate contact of relay 405. Relay 457 in operating closes at its contacts 466 an obvious energizing circuit for relay 400, which in operating, reverses and reduces the current flowing back to the toll office as previously described. Relay 457 also in attracting its outer right armature connects ground through interrupter 467 to complete the circuit for the operation of relay 408. Interrupter 467 which also operates at sixty interruptions per minute alternately energizes and releases relay 408, which relay at its contacts 491 interrupts the loop circuit leading back to the toll office and flashes the lamp 116 in exactly the same manner as just described for the incoming toll selector, Fig. 3. During the interval relay 408 is energized, resistance 460 is shunted across the winding of relay 405 to hold that relay energized. This holding circuit can be traced from battery, right-hand winding of relay 405, conductor 407, contacts 490 of relay 430, conductor 431, resistance 460, contacts 468 of relay 408 and left winding of relay 405 to ground. The operator upon receiving the busy signal disconnects as previously described and the switch is returned to normal.

In the past, it has been the practice in some cases to equip outgoing toll switching trunks at the toll office with an arrangement which delays the release of the toll train for a short interval, during which the operator can change cords even though the subscriber at station S has replaced his receiver. In the present system, means are provided including equipment at the machine switching office instead of at the toll office for accomplishing this result. One of the novel features of the present system is that the delayed release interval does not become operative until the subscriber's line has been seized. This is an improvement over previous arrangements in which the delayed release interval became operative as soon as the trunk was taken up by the operator, thereby causing the trunk and its associated switches to be held during this interval on all connections, whereas the delayed release interval is required only after the subscriber's line has been reached. This arrangement will now be described. Relay 400, Fig. 4, whose function is to operate, reverse and reduce the current flowing back to the toll office when the called line is seized, is provided with extra contacts 440, which when closed by the operation of relay 400 completes a circuit for the operation of relay 418 which may be traced from battery,

winding and left-hand normal contacts of relay 418, left normal contact of relay 463, inner right normal contact of relay 455, contacts 440 of relay 400 and conductor 419 to ground at the right alternate contact of relay 405. Relay 418 operates and locks up to ground through its left alternate contact and the left-hand normal contacts of relay 441. Relay 418, in operating, opens its outer right normal contact and removes relay 416 from the control of pulsing relay 405 and substitutes a locking circuit for it instead, which may be traced as follows: battery, winding of relay 416, conductor 417, outer right-hand alternate contacts of relay 418 and to ground through the right alternate contact of relay 416. Now should the toll operator start to change cords by removing the plug of the cord at present connected to the trunk, pulsing relay 405 will release and thereby connect ground over its right normal contact and the inner right alternate contact of relay 418 through winding of relay 441 and over its right normal contact to the start cam 442 of the timing interrupter. When the cam 442 rotates into position so that brush 448 engages the segment 492, battery is connected in the foregoing circuit and relay 441 operates and locks up under control of pulsing relay 405 and relay 418 in the following circuit: battery, right alternate contact and winding of relay 441, inner right alternate contact of relay 418, conductor 442 and to ground at the right normal contact of relay 405. Relay 441 in operating also closes a circuit whereby relay 418 is controlled by the carrying cam 443 which may be traced as follows: ground, cam 443, left alternate contacts of relay 441, left alternate contact and winding of relay 418 to battery. In the present system, cam 442 may be designed to close the circuit before traced for about $\frac{1}{4}$ second and to break it for $2\frac{3}{4}$ seconds and cam 443 may be designed to close the control circuit for relay 418 for $2\frac{3}{4}$ seconds and to maintain the circuit open for $\frac{1}{4}$ second. In the arrangement shown, it is assumed that the cams 442 and 443 are fixedly mounted with respect to each other on a constant revolving shaft driven by some suitable source of motive power. It will thus be seen that by aid of the arrangement described, the slow relay 416 which controls the release magnet 499, is maintained energized independently of the line relay 405 for an interval sufficiently long to enable the operator to change cords without the release of the connection.

When the operator plugs up the new cord, pulsing relay 405 operates again and relay 441 is released, thereby disconnecting cams 442 and 443. If, however, the second cord is not plugged up within approximately 3 seconds, the cam 443 releases relay 418 which in turn releases relay 441 and at the

same time restores relay 416 to the control of pulsing relay 405, which, however, has already been released and so relay 416 which is of the slow-to-release type eventually retracts its armature and restores the selector switch to normal.

In the foregoing discussion, it has been assumed that the called subscriber's receiver is on the switchhook. In case the subscriber has answered and the receiver is off the hook, flashing relay 408 will be operated, as before described, and therefore the pulsing relay 405 will be held operated in the following circuit: battery, right winding of relay 405, conductor 407, inner right normal contact of relay 430, conductor 431, outer right alternate contact of relay 408, and left-hand winding of relay 405 to ground so that the delayed release equipment will not function until the subscriber at the called station has hung up, at which time, however, it functions as described above, should the operator pull down the connection.

Now, assuming that the called subscriber at station S has replaced his receiver and the operator removes the plug for the purpose of breaking down the connection, relay 405 will release, which in turn will release relay 416 at the end of the delayed release interval. Relay 416 in retracting its outer left armature removes ground from the sleeve conductor 461 leading back to the relay 351 of the incoming selector, whereupon this relay releases and closes the circuit for release magnet 322 which may be traced from battery, winding of magnet 322, lower contacts of PON switch 323, lower normal contacts of relays 324 and 350, and to ground at the upper normal contact of relay 351. The removal of ground from conductor 428 by the release of the right-hand armature of relay 416 releases relay 425 and the retraction of the inner left armature of relay 416 and the outer right armature of relay 405 closes a circuit for the operation of release magnet 499. Relay 430 is energized in parallel with magnet 499 and opens at its outer right-hand armature the circuit for test brush 435 during the restoration operation. Relay 430, when energized, also locks itself up at its left alternate contact in a circuit including alternate contact PON switch 404 which will be opened when this switch is restored to normal.

The removal of ground from test brush 435 causes relay 510 to release, which in turn causes relay 500 to release which in retracting its lower armature closes a circuit for release magnet 519 which may be traced as follows: battery, winding of magnet 519, contact 570 of PON switch 516, lower normal contact of relay 505, lower normal contact of relay 500, and to ground at the lower normal contact of relay 510.

When the connector reaches its normal position it restores the PON switch to normal.

The withdrawal of the plug opens the circuit of relay 311 which closes, at its outer right normal contact a circuit for the operation of relay 303 which, when relay 400 releases to restore the current in the loop circuit to its original polarity and strength, opens the locking circuit for relay 301 which relay now releases and opens the trunk circuit to the mechanical office. Relay 400 does not release until after the called subscriber has replaced his receiver, and until this occurs jack 300 tests busy.

At night positions which are sometimes used as inward positions and sometimes as outward positions, a key 229 is provided for cutting the automatic ringing equipment out of service when it is not required.

What is claimed is:

1. In a telephone system, an operator's position, an automatic switch, a trunk circuit extending from the operator's position to said switch, subscribers' lines terminating in said switch, machine ringing equipment associated with said switch for ringing on said subscribers' lines, a cord circuit at said operator's position for connection with said trunk, a sender circuit adapted to be switched in connection with said cord circuit for setting said switch, and means associated with said sender circuit responsive to the seizure of an idle subscriber's line by the automatic switch for automatically initiating said machine ringing.

2. In a telephone system, an operator's position, an automatic switch, trunk circuits extending from the operator's position to said switch, subscribers' lines terminating in said switch and adapted to be seized thereby, machine ringing equipment associated with said switch for ringing on said subscribers' lines, a cord circuit at said operator's position for connecting with said trunk, an impulse sender and circuit thereof adapted to be switched in connection with said cord circuit for setting said switch, and means for controlling the operation of the ringing equipment to cause ringing to take place on the seizure of an idle subscriber's line and to prevent ringing on the seizure of a busy subscriber's line.

3. In a telephone system, an operator's position, an automatic switch, a trunk circuit extending from the operator's position to said switch, subscribers' lines terminating in said switch, a cord circuit at said operator's position for connection with said trunk circuit, a signal device at said position, a sender circuit adapted to be connected with said cord circuit for setting said switch, a source of ringing current, and means responsive to the seizure of an

idle subscriber's line by said automatic switch for automatically freeing said sender, for actuating said signal device to inform the operator that the connection has been established, and for momentarily applying ringing current from said source to the trunk.

4. In a telephone system, an operator's position, an automatic switch, a trunk circuit extending from the operator's position to said switch, subscribers' lines terminating in said switch, machine ringing for ringing on said subscribers' lines, a cord circuit at said operator's position for connection with said trunk, a sender circuit adapted to be connected with said cord circuit, means responsive to the seizure of an idle subscriber's line by said automatic switch to automatically disconnect said sender circuit from said cord, and other means also responsive to the seizure of said idle line for automatically initiating said machine ringing before said sender circuit is disconnected from the cord.

5. In a telephone system, an operator's position, an automatic switch, a trunk circuit terminating at one end in said manual switch and at its other end in said automatic switch, manual circuits for connection with the manual switch of the trunk, a sender for setting said automatic switches adapted to be associated with said trunk by means of said manual connecting circuits, means located at the automatic end of said trunk actuated a predetermined interval after the removal of said manual connecting circuit from said trunk for releasing said switches, and means actuated by the connection of another manual connecting circuit to said trunk within said interval for preventing the release of said switches.

6. In a telephone system, an operator's position, a manual switch thereat, an automatic switch, a trunk circuit terminating at one end in said manual switch and at its other end in said automatic switch, subscribers' lines terminating in said automatic switch and adapted to be seized thereby, manual circuits for connecting with the manual switch, a sender for setting said automatic switch to seize one of said subscribers' lines, said sender being adapted to be associated with said trunk by means of said manual connecting circuits, means located at the automatic end of said trunk actuated a predetermined interval after the removal of said manually connected circuit from said trunk for releasing said switch, and means, under control of the seized subscriber's line, for preventing the release of said switches when another manual circuit is connected to said trunk within said interval.

7. In a telephone system, an operator's

position, a manual switch thereat, an automatic switch, a trunk circuit terminating at one end in said manual switch and at its other end at said automatic switch, subscribers' lines terminating in said automatic switch and adapted to be seized thereby, manual circuits for connecting with the manual switch of said trunk, a dial for setting said automatic switch to seize one of said subscribers' lines, said dial being adapted to be associated with said trunk by means of said manual connecting circuits, means located at the automatic end of said trunk actuated a predetermined interval after the removal of said manually connecting circuit from said trunk for releasing said switch, and means actuated by the connection of another manual connecting circuit to said trunk within said interval for preventing the release of said switches when said automatic switch is in connection with one of said subscribers' lines.

8. In a telephone system, an operator's position, a manual switch thereat, an automatic switch, a trunk circuit terminating at one end in multiple terminals of said manual switch and at its other end in said automatic switch, manual circuits for connection with the terminals of the manual switch, an impulse sender for setting said automatic switch adapted to be associated with said trunk by means of one of said manual connecting circuits, means located at the automatic end of said trunk actuated a predetermined interval after the removal of said manual connecting circuit from said trunk for releasing said switch, means actuated by the connection of another manual connecting circuit to said trunk within said interval for preventing the release of said switches, and means for causing the multiple terminals of said trunk to test busy during said interval.

9. In a telephone system, an operator's position, a jack thereat, an automatic switch, a trunk circuit terminating at one end in said jack and at its other end in said automatic switch, cord circuits for connection with the jack of the trunk, a sender for setting said switches adapted to be associated with said trunk by means of one of said cord circuits, a timing device located at the automatic end of said trunk circuit, controlling relays for said switches which are rendered effective a predetermined interval after the disconnection of said cord circuit from said trunk jack, and means also located at the automatic end of said trunk actuated by the connection of another cord circuit with said trunk jack within said time interval for removing control of the release of said switches from said timing device.

10. In a telephone system, an operator's position, a jack thereat, an automatic switch, a trunk circuit terminating at one

end in said jack and at its other end in said automatic switch, subscribers' lines also terminating in said automatic switch and adapted to be seized thereby, cord circuits for connecting with the jack of said trunk, an impulse sender for setting said switch to seize one of said subscribers' lines, said sender being adapted to be associated with said trunk by means of one of said cord circuits, a timing device located at the automatic end of said trunk circuit, controlling relays for said switches which are rendered effective a predetermined interval after the disconnection of said cord circuit from said trunk jack, and means also located at the automatic end of said trunk jointly controlled by said seized subscriber's line and by the connection of another cord circuit with said trunk jack for removing the control of the release of said switch from said timing device during said time interval.

11. In a telephone system, an operator's position, a jack thereat, an automatic switch, a trunk circuit terminating at one end in said jack and at its other end in said automatic switch, subscribers' lines also terminating in said switch and adapted to be seized thereby, cord circuits for connecting with said trunk jack, a dial for setting said switch adapted to be associated with said trunk by means of one of said cord circuits, a timing device located at the automatic end of said trunk circuit, controlling relays for said switch which are rendered effective a predetermined interval after the disconnection of said cord circuit from said trunk jack, and means also located at the automatic end of said trunk actuated by the connection of another cord circuit with said trunk jack within said time interval for removing the control of the release of said switches from said timing device when said switch is in connection with an idle subscriber's line.

12. In a telephone system, an operator's position, multiple jacks thereat, an automatic switch, a trunk circuit terminating at one end in said multiple jacks and at its other end in said automatic switch, subscribers' lines also terminating in said automatic switch adapted to be seized thereby, cord circuits for connection with said trunk jacks, an impulse sender for setting said switch adapted to be associated with said trunk by means of one of said cord circuits, a timing device located at the automatic end of said trunk circuits, controlling relays for said switch which are rendered effective a predetermined interval after the disconnection of said cord circuits from said trunk jacks, means also located at the automatic end of said trunk actuated by the connection of another cord circuit to said trunk within said time interval for removing control of the release of said switch from said timing device,

and means for rendering said trunk busy to other cord circuits attempting to connect therewith during said time interval.

13. In a telephone exchange system, an operator's position, a jack thereat, an automatic switch, a two-conductor trunk terminating at one end in said jack and at its other end in said automatic switch, a cord circuit at said position having a calling plug for connection with said jack, a sender for setting said automatic switch adapted to be associated with said trunk by means of said cord circuit, means located at the automatic end of said trunk and actuated a predetermined interval after the disconnection of said calling plug from said jack for releasing said switches, and means also located at the automatic end of said trunk actuated by the connection of another cord circuit to said trunk within said interval for preventing the release of said switches.

14. In a telephone system wherein operators' cord circuits are used for extending connections, selective switches, a plurality of two-conductor trunks each leading to certain of said switches, means including said cord circuits for establishing a connection to any one of said trunks, means for operating the selective switches to extend such trunk, and means controlled over the two conductors of such trunk for holding the selective switches associated with such trunk while the operator is changing from one cord to another.

15. In a telephone system, selective switches, a plurality of two-conductor inter-office trunks each leading to certain of said switches, means for establishing a connection to any one of said trunks, means for operating the selective switches to extend said trunk, a time measuring device, means controlled over said trunk and responsive to the disestablishment of said connection for starting the time measuring device in operation, and means operated by said device after a definite interval for releasing the selective switches.

16. In a telephone system, selectively controlled switches, a plurality of trunks each leading to certain of said switches, means for establishing connections to any one of said trunks, means for operating the switches to extend such trunks, and means for holding the selected switches associated with any one of said trunks for a predetermined interval of time following disconnection therefrom, said means controlled over said trunk.

17. In a telephone exchange system, a trunk circuit, an automatic switch accessible thereto for extending a connection to a called subscriber, a line relay for said switch, magnets controlled thereby for setting and releasing said switch, a loop circuit for said switch, a dial for intermittently interrupting said loop circuit to control certain of

said magnets to set said switch, sources of signaling current, means for automatically applying current from one of said sources to said called line to signal over said line, means for applying current from another of said sources to said trunk to initiate said automatic signaling, and a transformer connected between said second mentioned source and said trunk to prevent said release magnet from becoming effective during said automatic signaling.

18. In a telephone exchange system, a trunk circuit, an automatic switch accessible thereto for extending a connection to a called subscriber, a line relay for said switch, magnets controlled thereby for setting said switch, a loop circuit for said relay, a dial for intermittently interrupting said loop circuit to control certain of said magnets to set said switch, sources of ringing current, means for automatically applying current from one of said sources to said called line to signal said line, means for applying current from another of said sources to said trunk to initiate said automatic ringing, and a transformer connected between said second mentioned source and said trunk to maintain said line relay operated during ringing.

19. In a telephone exchange system, a trunk circuit, an automatic switch accessible to said trunk circuit, a cord circuit connected to said trunk circuit, a key, a dial, means controlled by the actuation of said key and said dial for connecting said dial in operative relationship to said switch, a source of current, and automatic means operative after said switch has been set to disconnect said dial and to apply current from said source to said trunk circuit.

20. In a telephone exchange system, a trunk circuit, an automatic switch accessible to said trunk circuit, a cord circuit in connection with said trunk circuit, a key, a dial, means controlled by the actuation of said key and said dial for connecting said dial in operative relationship with said switch, a source of current, means operative after said switch has been set upon an idle subscriber's line to automatically disconnect said dial and to apply current from said source to said trunk circuit, and means for preventing the application of said current to said trunk circuit if said switch is set on a busy subscriber's line.

21. In a telephone exchange system, a trunk circuit, an automatic switch accessible to said trunk circuit, subscribers' lines terminating in said automatic switch and adapted to be seized thereby, a cord circuit connected to said trunk circuit, a key, a dial, means controlled by the actuation of said key and said dial to connect said dial in operative relationship to said switch, a source of ringing current adapted to be applied to said

trunk circuit, and means controlled over said trunk circuit to prevent the application of said ringing current to said trunk circuit when said automatic switch engages a busy line.

22. In a telephone exchange system, a trunk circuit, an automatic switch accessible to said trunk circuit, a cord circuit connected to said trunk circuit, a key, a dial, means controlled by the actuation of said key and said dial for connecting said dial in operative relationship to said switch, a source of ringing current, and means controlled over said trunk circuit to automatically disconnect said dial and to automatically apply ringing current from said source to said trunk circuit.

23. In a telephone exchange system, the combination with telephone lines, automatic switches, groups of trunks, an operator's position, cord circuits thereat, a supervisory lamp for each cord circuit, means controlled from said position for setting said switches to interconnect said lines over said cord circuits and said trunks, a relay common to the cord circuits of the position for controlling said signal in one manner, and a relay individual to the cord circuits for controlling said signal in another manner.

24. In a telephone exchange system, a trunk circuit, an automatic switch accessible to said trunk circuit, subscribers' lines terminating in said switch and adapted to be seized thereby, a cord circuit connected to said trunk circuit, a key, a dial, means controlled by the actuation of said key and said dial for connecting said dial in operative relationship to said automatic switch, a source of ringing current and means controlled over said trunk circuit to auto-

atically disconnect said dial and to automatically apply ringing current from said source to said trunk circuit only when the seized subscriber's line is idle.

25. In a telephone exchange system, the combination with telephone lines, automatic switches, groups of trunks, an operator's position, cord circuits thereat, a supervisory lamp for each cord circuit, means controlled from said position for setting said switches to interconnect said lines over said cord circuits and said trunks, a relay common to the cord circuits of the position for flashing said signal to give a busy indication, and a relay individual to the cord circuits for giving a steady indication as a disconnect signal.

26. In a telephone exchange system, the combination with telephone lines, automatic switches, groups of trunks, terminating therein, an operator's position, cord circuits thereat, a supervisory lamp for each cord circuit, means at said position for controlling said switches to interconnect said lines over said trunks, a relay common to the cord circuits of the position controlled by the busy condition of the selected group of trunks for flashing said lamp at a certain rate and controlled by the busy condition of the called line for flashing said lamp at a different rate, and a relay individual to the cord circuits controlled by the called subscriber for lighting said lamp steadily as a disconnect signal and intermittently as a flashing signal.

In testimony whereof, we have signed our names to this specification this 14th day of August, 1923.

JOHN F. TOOMEY.
HENRY E. PHELPS.