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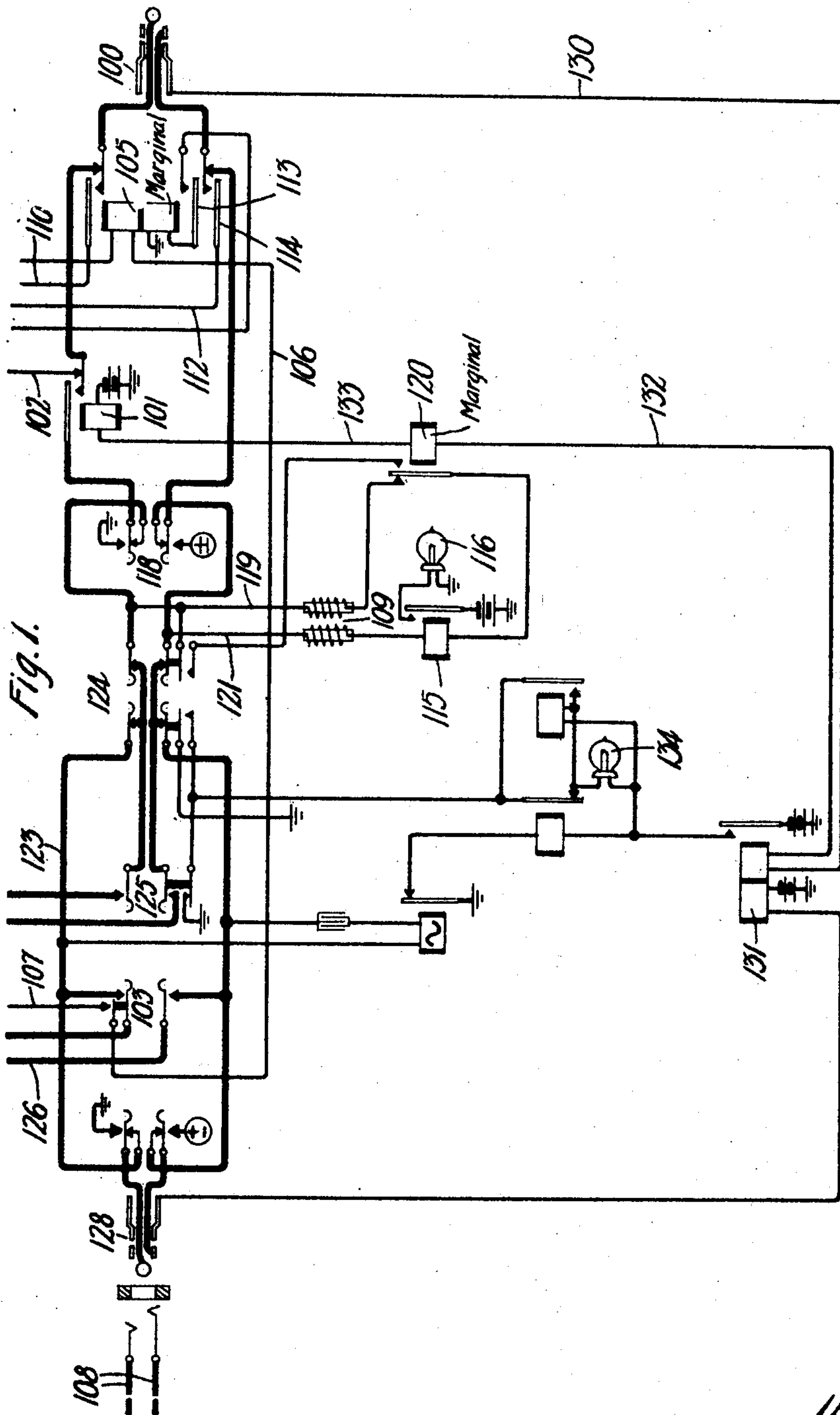
J. F. TOOMEY

1,623,139

TELEPHONE EXCHANGE SYSTEM

Filed April 4, 1922

6 Sheets-Sheet 1



Inventor:
John F. Toomey
by William R. Ballard
ATT'Y.

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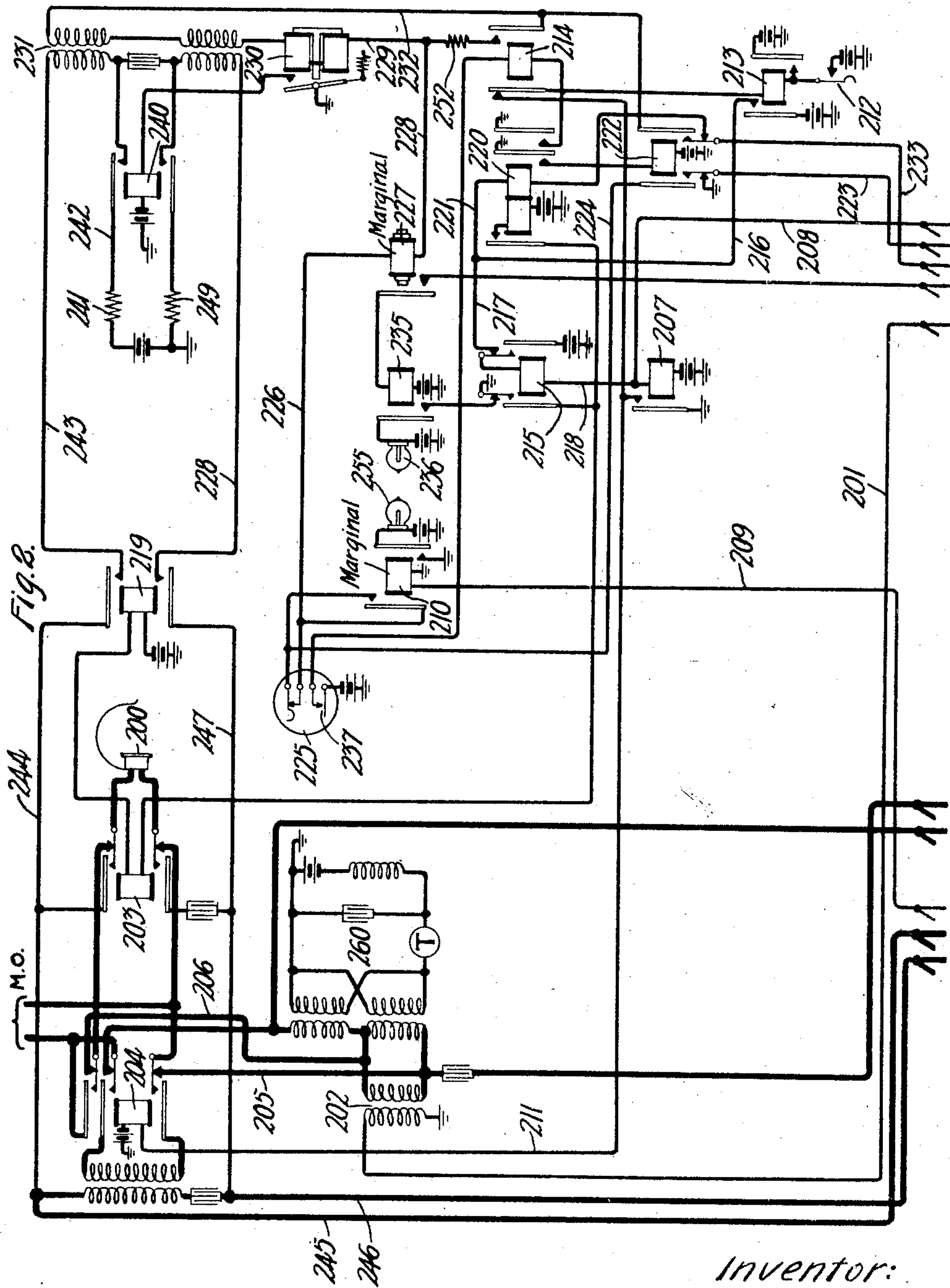
J. F. TOOMEY

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TELEPHONE EXCHANGE SYSTEM

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6 Sheets-Sheet 2



Inventor:
John F. Toomey
by William R. Ballard
ATT'Y.

April 5, 1927.

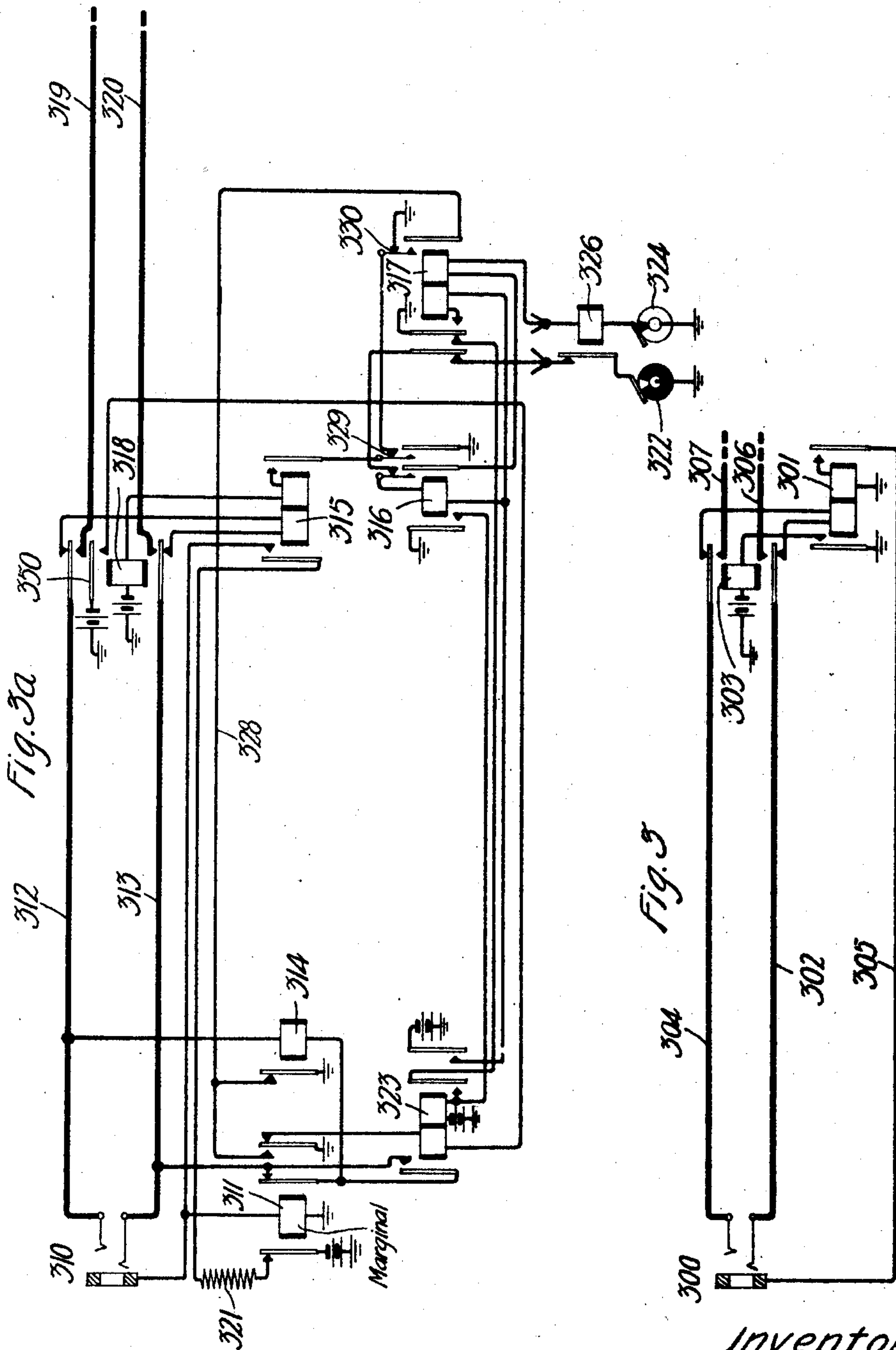
J. F. TOOMEY

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TELEPHONE EXCHANGE SYSTEM

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6 Sheets-Sheet 3



Inventor:
John F. Toomey
by William V. Phalland
Att'y

April 5, 1927.

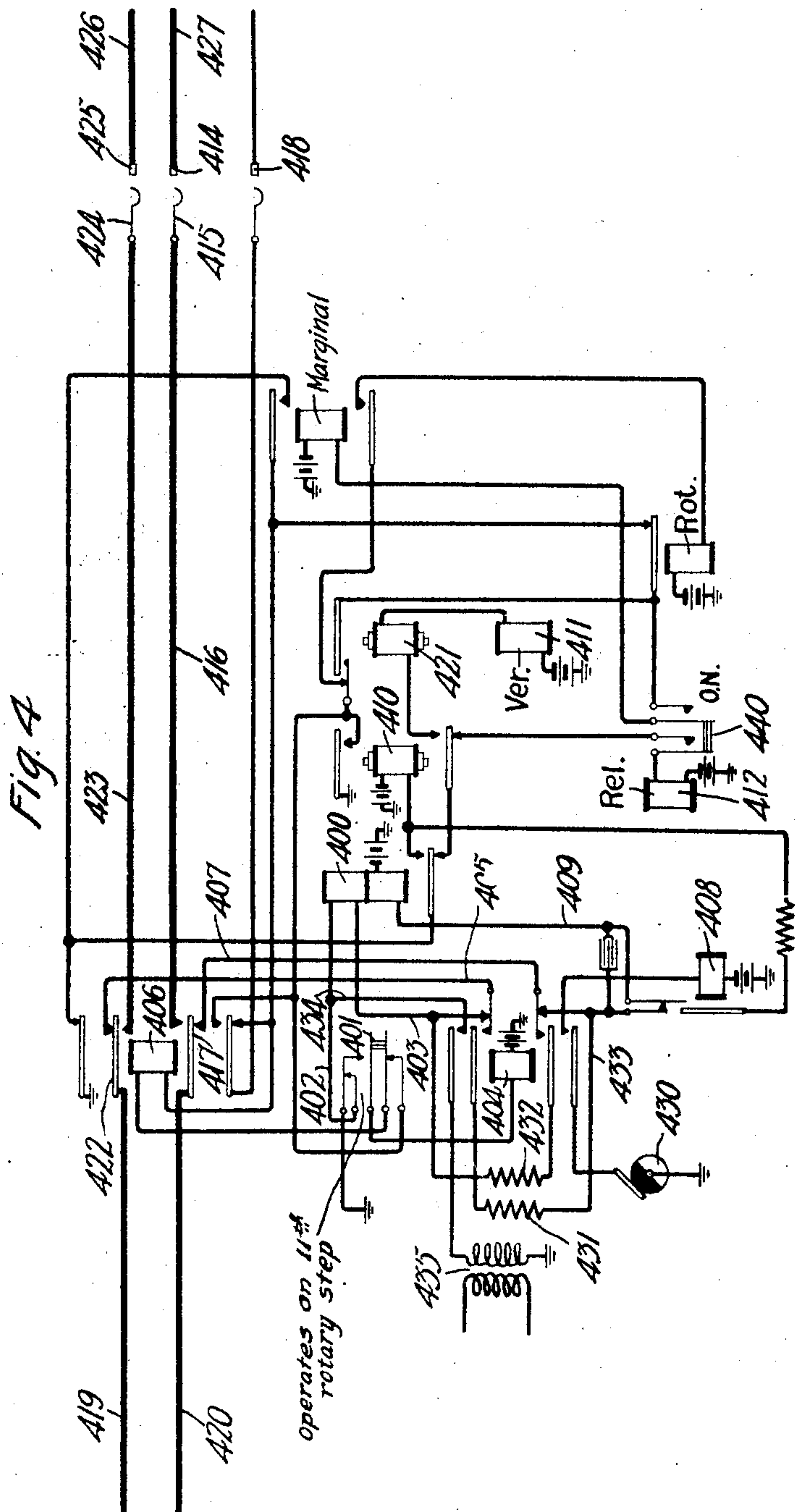
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J. F. TOOMEY

TELEPHONE EXCHANGE SYSTEM

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6 Sheets-Sheet 4



Inventor:
John F. Toomey
by William P. Ballard
Att'y.

April 5, 1927.

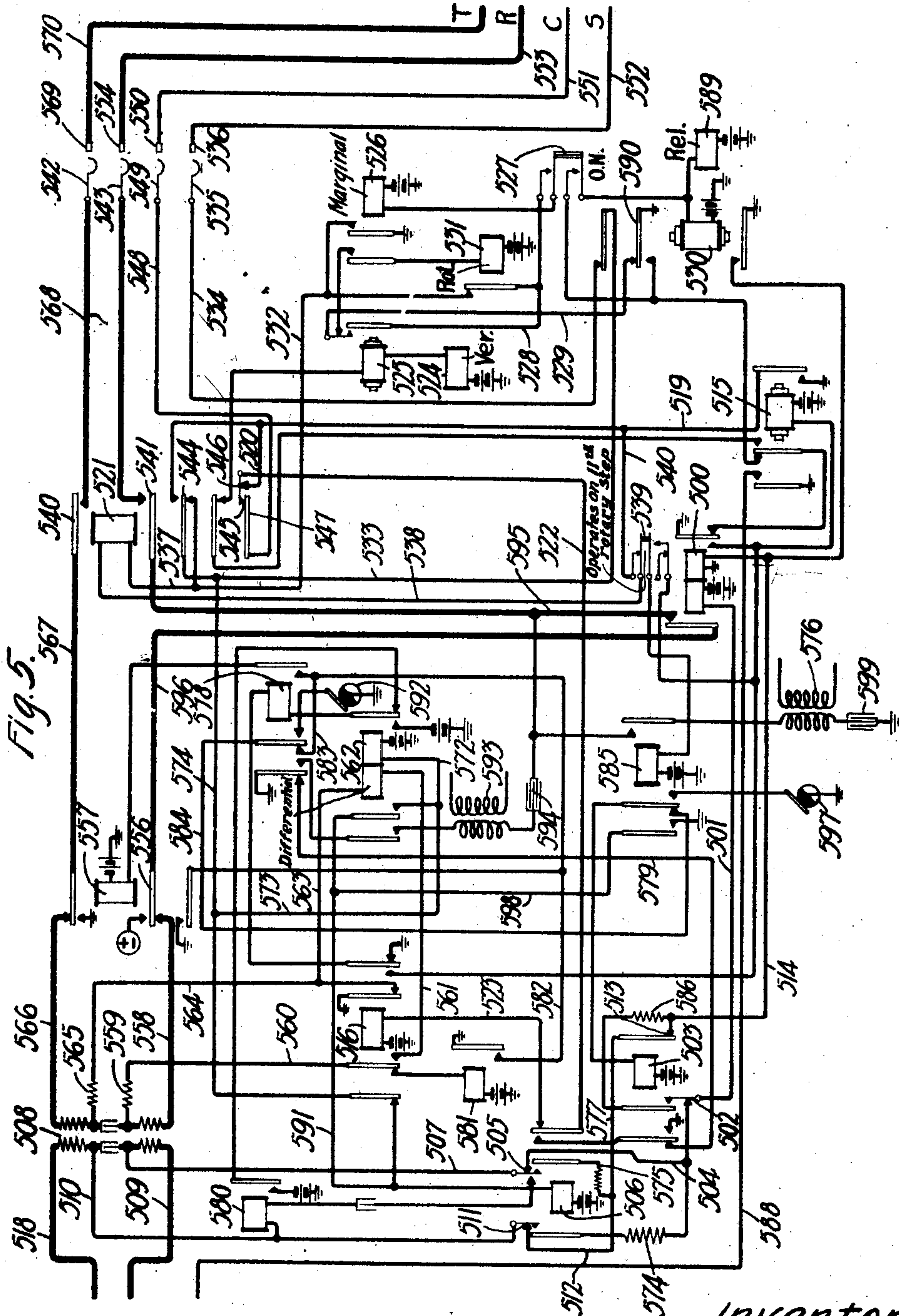
J. F. TOOMEY

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TELEPHONE EXCHANGE SYSTEM

Filed April 4, 1922

6 Sheets-Sheet 5



Inventor:
John F. Toomey
by William P. Balland
ATT'Y.

April 5, 1927.

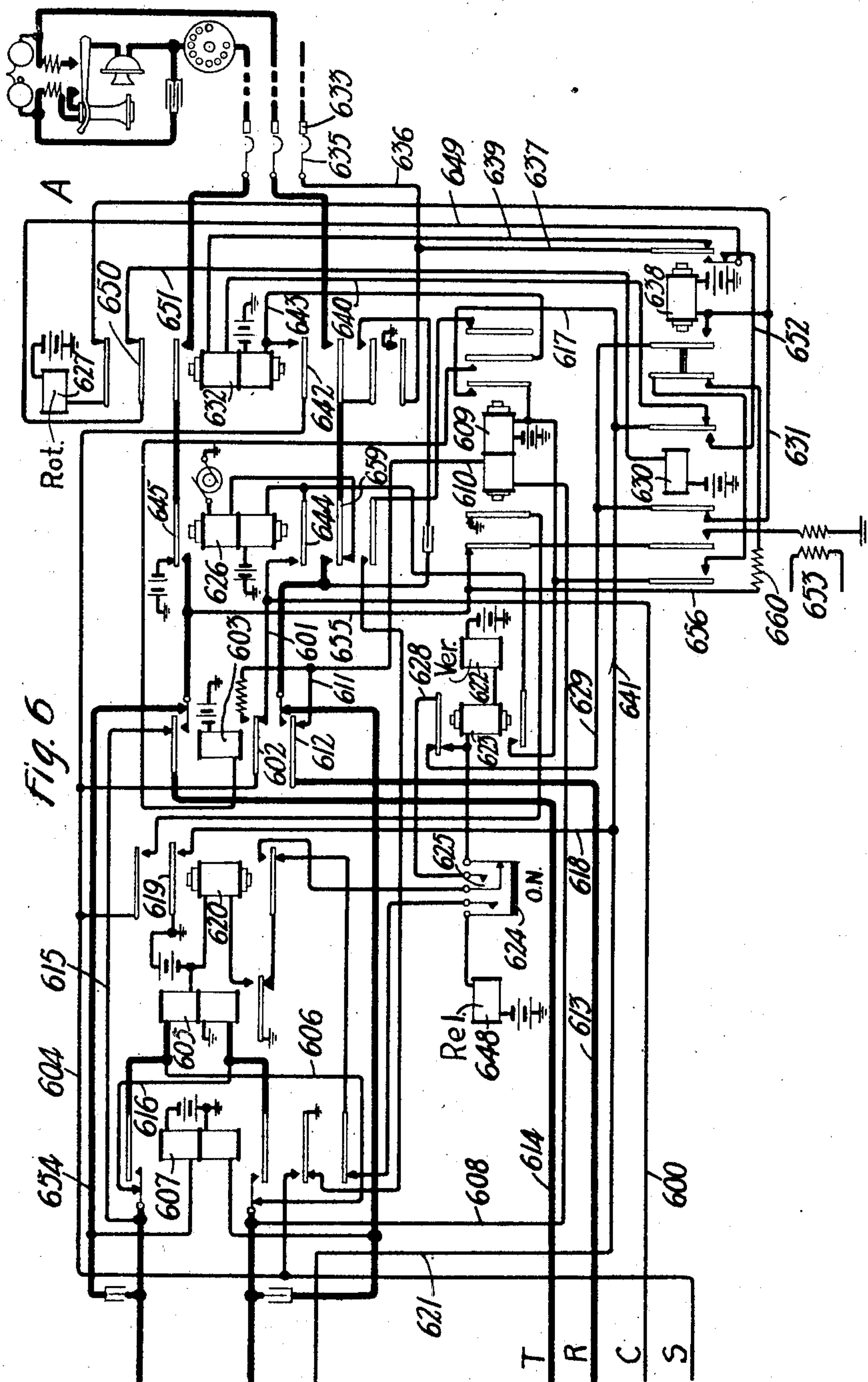
J. F. TOOMEY

1,623,139

TELEPHONE EXCHANGE SYSTEM

Filed April 4, 1922

6 Sheets-Sheet 6



Inventor:
John F. Toomey
by William R. Ballard
Att'y.

UNITED STATES PATENT OFFICE.

JOHN F. TOOMEY, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed April 4, 1922. Serial No. 549,480.

This invention relates to telephone exchange systems, and particularly to automatic toll switching trunks; that is, to circuit arrangements for enabling toll operators to build up toll connections to automatic subscribers' lines.

The object of this invention is to improve the general operating efficiency of circuits of this character.

A feature of the invention is the provision of a circuit arrangement wherein signals indicating the progress of the automatic switches in building up the connection are transmitted by the switches at the machine switching office to the toll operator who is setting up the connection, and also to the distant toll operator. Preferably the signals given the former operator are visible signals, and those given the latter are audible signals. In the arrangement shown, when any selector encounters a busy trunk group, it causes the calling supervisory lamp in the toll cord to flash, and a tone to be impressed on the toll line leading to the distant office. When the desired subscriber's line is found busy the said lamp is flashed but at a different rate from the all trunks busy rate, and a tone of a different character from the all trunks busy tone is impressed on the toll line leading to the distant office. When the connector finds the line idle the lamp is steadily lighted as a ringing signal to the operator.

A further feature is the provision of a circuit arrangement wherein a dial common to the toll cords is connected to the calling plug of the used cord by a key, and simultaneously therewith the calling plug is disconnected from the cord strands to prevent the relatively heavy current used for stepping the automatic switches from flowing into the toll cord and injuring the impedance coil which is permanently bridged there-across in series with the calling supervisory relay, which bridge must be provided for supervisory purposes. Although this circuit is disconnected from the calling end of the cord, as described, the failure of the toll operator to restore the dialing key after dialing, will not prevent the local and distant toll operators from receiving the proper signals indicating either that a selector has encountered a busy trunk group, or that the desired subscriber's line is busy or idle. This is brought about by providing means

for operating the calling supervisory relay by a circuit including alternate contacts of the dialing key, provided the switches at the machine switching office have cut in the necessary resistances to reduce the relatively heavy stepping current to a value which will not injure the impedance coil referred to. Moreover, if the operator does restore the key, but the said resistances have not been cut in, means is provided for preventing the relatively heavy stepping current from flowing into the toll cord, and the toll operator is given a signal indicating that the circuits have not functioned properly.

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 an outgoing trunk circuit to a machine switching office;

Fig. 3^a shows an outgoing trunk circuit to a machine switching office, provided with equipment for giving a delayed release;

Fig. 4 shows an incoming selector at the machine switching office;

Fig. 5 shows a toll transmission selector; and

Fig. 6 shows a combination toll and local 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 she 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 when operated disconnects the calling plug 100 from the normal bridge across the cord including the supervisory relay 115 and the impedance coil 109, and transfers the calling plug into connection with the common dialing circuit shown in Fig. 2. Relay 105 locks up in a circuit including the alternate contact of marginal relay 227.

The operator then rotates the dial 225 in accordance with the digits of the desired number. If the incoming selector of Fig. 4,

or any of the succeeding selectors at the machine switching office finds the desired trunk group busy, this selector reverses the current in the trunk leading back to the toll board, and including alternate contacts of the relay 105 and the windings of a polarized relay 230. Polarized relay 230 operates a relay 240 to apply current to a circuit including alternate contacts of the dialing key 103, the answering end of the toll cord, and the bridge including the calling supervisory relay 115 and impedance coil 109, to cause the supervisory relay to flash the calling supervisory lamp 116 to indicate the all trunk busy condition to the operator, whereupon she will cease dialing and break down the connection and attempt to establish it later. If, however, none of the selectors encounters a busy trunk group, but the connector finds the desired subscriber's line busy or idle, resistances are included in the trunk circuit at the machine switching office leading back to the toll board. The introduction of these resistances releases the marginal relay 227, and allows relay 105 to release and thereby to connect the calling supervisory relay to the calling plug and thence to the trunk, provided the dialing key has been restored. The calling supervisory relay is then operated in this circuit to light the calling supervisory lamp if the connector found the line idle, and to flash the lamp if the connector finds the line busy at a different rate than the "all trunks" busy flash.

However, if the dialing key 103 is not restored the relay 105 is not released to connect the calling supervisory relay to the calling plug upon the inclusion of said resistances at the machine switching office due to a circuit for said relay closed at alternate contacts of said dialing key. Under these circumstances, the circuit for causing the operation of the calling supervisory relay includes alternate contacts of relay 105 and alternate contacts of the dialing key and the answering end of the cord.

Having described in a general way the operation of the system, it is thought the invention will be more readily understood from a detailed description of the operations involved in setting up a connection.

The toll operator having received the number of the desired substation from the recording operator, or in any other suitable manner, touches the tip of her plug 100 to the sleeves of the jacks, such as 300, to select an idle trunk leading to the machine switching office in which the desired line terminates, and inserts the plug in the jack of such idle trunk. The busy condition of a trunk is indicated by battery on the sleeve of the jack 300, which produces a click in the receiver 200 of the operator's head set in the following manner: battery from the sleeve, over the tip of the plug 100, normal

contacts of relays 105 and 101, conductors 102, 201, 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 following circuit: lower terminal of the receiver 200, lower normal contact of relays 203 and 204, conductor 205, the secondary winding of induction coil 202, conductor 206, upper normal contacts of relays 204 and 203 to the upper terminal of receiver 200. The operator now actuates the monitoring key 103 of the toll cord which closes a circuit for relay 207 as follows: battery, relay 207, conductor 208, upper winding of relay 105, conductor 106, alternate contact of key 103, conductors 107, 209, relay 210 to ground. Relays 105 and 210 are marginal and do not operate in this circuit. Relay 207 operates, closing a circuit over conductor 211 for relay 204. Relay 204 operates and prepares the operator's head set circuit for monitoring. The operator now actuates key 212, which operates relay 213 over a circuit including the normal left contact of relay 214 and the alternate contact of relay 207. Relay 213 in attracting its right armature locks in the circuit traced, so that it remains energized after the operator releases key 212. In attracting its left armature relay 213 closes a circuit for operating relays 215 and 105, this circuit including conductors 216, 217, normal contact of relay 215, relay 215, conductors 218, 208, upper winding of relay 105 to ground through relay 210 over the circuit previously traced. This circuit provides an increased current for relay 210 but still not sufficient to cause its energization. Relay 215 in attracting its right armature locks to conductor 218, and in attracting its left armature closes a circuit to operate relays 203 and 219, which operate to prepare a circuit for transmitting audible signals which may come back from the machine switches at the automatic office to the toll operator's head set and over the toll line 108 to the distant toll operator, as will more fully appear hereinafter.

Relay 105 in operating connects the dialing equipment with the plug 100, and opens up the cord circuit so that the relatively heavy current which must be used to set the automatic switches at the machine switching office will not flow into the cord and injure the low resistance impedance coil 109 bridged across the cord. Relay 105 in operating closes the following circuit for relay 301 in the trunk (Fig. 3) and relay 220: battery, left armature and front contact of relay 213, conductors 216, 221, right winding of relay 220, right normal contact of relay 222, conductors 233, 112, armature 114 and alternate contact of relay 105, rings of the plug and jack, conductor 302, lower normal contact of relay 303, left winding of

relay 301, upper normal contact of relay 303, conductor 304, tips of the jack and plug, upper alternate contact of relay 105, conductors 110, 223, to ground at the left normal contact of relay 222. Relay 220 at its left armature locks to ground at the left alternate contact of relay 215, and in attracting its inner right armature operates relay 222. Relay 301 at its right armature closes a locking circuit including its right winding, conductor 305, sleeves of the jack and plug, sleeve conductor 130, right winding of relay 131, conductor 132 marginal relay 120, conductor 133, relay 101 to battery. Relays 101 and 131 operate in this circuit. Relay 101 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 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 108. Relay 120 is marginal and does not operate in this circuit, leaving the supervisory relay 115 bridged across the toll cord. At its left armature relay 201 operates relay 303 to extend conductors 302, 304 to conductors 306, 307 leading to the distant machine switching office and terminating thereat in the incoming selector, shown in Fig. 4. Relays 303 and 222 in operating close the following circuit for the impulse relay 400 of said selector: ground at the normal contact of switch 401 operated only on the eleventh rotary step of the incoming selector, conductor 402, upper winding of relay 400, conductor 403, normal contact of relay 404, conductor 405, upper normal contact and armature 422 of relay 406, conductors 419, 307, upper alternate contact of relay 303, conductor 304, tips of the jack and plug, upper alternate contact of relay 105, conductors 110, 223, left alternate contact of relay 222, conductor 224, impulse contact of the dial 225, conductor 226, slow marginal relay 227, conductors 228, 229, polarized relay 230, primary winding of induction coil 231, conductor 232, right alternate contact of relay 222, conductors 233, 112, armature 114 and alternate contact of relay 105, rings of the plug and jack, conductor 302, lower alternate contact of relay 303, conductors 306, 420, armature 417 and normal contact of relay 406, conductor 407, normal contact of relay 404, normal contact of relay 408, conductor 409, lower winding of the impulse relay 400 to battery. Relay 400 in operating closes a circuit for slow relay 410 from ground at the uppermost normal contact of relay 406. Relay 410 in operating its lower armature interposes a break in the circuit of release magnet 412 and connects the vertical magnet 411 through the usual slow relay 421 to the back contact of the impulse relay 400, preparatory to receiving the impulses

from the dial 225. Marginal relay 227 operates in the loop circuit traced for the impulse relay 400, and closes a circuit including relay 235 and the lower winding of relay 105, but since relay 215 is operated at this time, lamp 236, whose function will later appear, will not light.

The operator now turns the dial 225 for the first digit of the wanted number. The dial in moving off-normal closes contact 237 which operates relay 214 over a circuit including the outer right armature and alternate contact of relay 220. Relay 214 at its right armature effectively short-circuits the polarized relay 230 and the primary of the induction coil 231 to remove them from the loop circuit traced for the impulse relay 400. The vertical magnet 411 receives impulses from impulse relay 400 in the well-known manner and raises the selector brushes to the desired level. The selector then hunts for an idle trunk leading to a toll transmission selector, Fig. 5. The operation of the incoming selector in hunting for an idle trunk will not be described in detail since it is the same as that shown and described in Patent No. 1,377,225, issued May 10, 1921, to A. J. Seymour. Upon the seizure of an idle trunk, relay 406 operates, cuts off the bridge containing the impulse relay 400 and extends the trunk conductors 419, 420, through to the toll transmission selector, Fig. 5. When relay 406 cuts through as described, the operator gets a click in her set to indicate that the selector has functioned properly. The click is transmitted over an obvious circuit to the repeating coil 231 from battery at impulse relay 500 which now operates over the following circuit: free pole of battery, left winding of relay 500, conductor 501, normal contact 502 of relay 503, conductor 504, normal contact 505 of relay 506, conductor 507, lower left winding of repeating coil 508, conductors 509, 427, multiple terminal 414, brush 415, conductor 416, armature 417 and alternate contact of relay 406, conductors 420, 306, lower alternate contact of relay 303, conductor 302, rings of the jack and plug, armature 114 and alternate contact of relay 105, conductors 112, 233, right armature and alternate contacts of relays 222, 214, resistance 252, conductor 228, slow marginal relay 227, conductor 226, impulse contact of the dial 225, conductor 224, left armature and alternate contact of relay 222, conductors 223, 110, upper armature and alternate contact of relay 105, tips of the plug and jack, conductor 304, upper alternate contact of relay 303, conductors 307, 419, armature 422 and alternate contact of relay 406, conductor 423, brush 424, terminal 425, conductors 426, 518, upper left winding of repeating coil 508, conductor 510, normal contact 511 of relay 506, conductors 512, 577, normal contact 513

of relay 503, conductor 514 to ground through the right winding of relay 500. The impulse relay 500 in attracting its right armature energizes slow relay 515. This relay in attracting its outer left armature places ground on the test multiples 418 to cause this trunk to test busy in the well-known manner. When the relay 515 operates it closes at its right armature the following circuit for relay 516: ground, right armature and front contact of relay 515, conductors 519, 520, normal contact 546 of relay 521, conductor 522, outer right armature and normal contact of relay 506, conductor 523, relay 516, battery. The second operation of the dial by the operator transmits the corresponding digit of the desired line designation, causing relay 500 to transmit impulses over the following circuit to the vertical magnet 524 of the selector through the usual slow relay 525: ground, right armature and back contact of relay 500, inner left armature and alternate contact of relay 515, normal contact of relay 521, slow relay 525, magnet 524 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 500 energized, slow relay 525 after a slight interval, releases. When the relay 525 operated on the first impulse and the selector took its first step, relay 526 operated over the following circuit: free pole of battery, relay 526, contact of off-normal switch 527, conductor 528, armature and front contact of relay 525, conductor 529, armature 590 and back contact of slow relay 530 to ground. In attracting its inner armature, relay 526 locks in a circuit including the back contact of the rotary magnet 531. Upon the cessation of the impulses and the release of slow relay 525, the circuit of the rotary magnet is closed as follows: free pole of battery, magnet 531, outer armature and alternate contact of relay 526, normal contact of relay 525, conductor 529 to ground at the armature 590 and back contact of relay 530. The rotary magnet advances the brushes onto the terminals of the first trunk, and at the end of its stroke opens the locking circuit of the relay 526, which releases, opening the circuit of the rotary magnet. If this trunk is busy, relay 526 is again operated over the following circuit: free pole of battery, relay 526, upper contact of switch 527, armature and back contact of rotary magnet 531, conductor 532, back contact and armature 544 of relay 521, conductor 533, upper normal contact of relay 530, conductor 534, brush 535 to ground at multiple 536 of the busy connector. Relay 526 in attracting its inner armature again locks up, and at its other armature again closes the circuit of the rotary magnet 531 which advances the brushes to the next trunk, and at the end of its stroke opens the locking circuit of relay 526, which in retracting its armature opens the circuit of the rotary magnet 531. When an idle trunk is found, relay 521 operates over the following circuit: free pole of battery, relay 526, contact of switch 527, armature and normal contact of rotary magnet 531, conductors 532 and 537, relay 521, conductor 538, normal contact of switch 539, operated only on the eleventh rotary step of the transmission selector, conductors 540, 519 to ground at the right armature and alternate contact of relay 515. Relay 526 is marginal and does not operate in this circuit in series with relay 521. Relay 521 operates, and in attracting its armatures 540 and 541 extends the talking conductors through to the talking brushes 542, 543. This extension of the conductors is heard as a click through the repeating coils 508 and through the repeating coil 231, the same as when the connection was extended to relay 500. In this case it is extended to and receives battery at relay 605. The attraction of the armature 544 of relay 521 grounds the test brush 535, and consequently test multiples 536 of the selected trunk, causing the same to test busy to other selectors. The contact 545 is made before the contact 546 is broken by the armature 547 of relay 521. Consequently relay 516 is maintained energized over the following circuit: free pole of battery, relay 516, conductor 523, outer right armature and normal contact of relay 506, conductor 522, contact 545, armature 547, conductor 548, brush 549, multiple 550, control conductors 551, 600, (Fig. 6,) conductor 601, armature 602 and normal contact of relay 603, conductors 604, 552, multiple 536, brush 535, conductor 534, armature and normal contact of relay 530, conductor 533, armature 544 and alternate contact of relay 521, conductor 519, right armature and alternate contact of relay 515, to ground. Thus the circuit for relay 516, Fig. 5, will be maintained closed as the circuit is extended for a purpose which will later appear. The switch of Fig. 6 to which the connection has been extended is a combination toll and local connector, containing multiples of automatic subscribers' lines in its banks. This switch is accessible not only to the toll selectors of Fig. 5, but also to the local selectors which are used by the subscribers in building up their own connections. The seizure of the connector closes the following circuit for the impulse relay 605 thereof: free pole of battery, upper winding of relay 605, conductor 606, normal contact of relay 607, conductor 608, left winding of slow relay 609, conductors 610, 611, armature 612 and normal contact of relay 603, conductors 613, 553, terminal 554, brush 543, armature 541 and

alternate contact of relay 521, left armature and alternate contact of relay 500, armature 556 and normal contact of relay 557, conductor 558, lower right winding of repeating coil 508, resistance 559, conductor 560, inner left armature and alternate contact of relay 516, conductor 561, left winding of relay 562, conductors 563, 564, resistance 565, upper right winding of repeating coil 508, conductor 566, upper armature and normal contact of relay 557, conductor 567, armature 540 and alternate contact of relay 521, conductor 568, brush 542, multiple 569, conductors 570, 614, upper armature and normal contact of relay 603, conductor 615, upper normal contact of relay 607, conductor 616 to ground through the lower winding of relay 605. When relay 521 operated and closed the loop circuit including the left winding of relay 562, a circuit was closed for the right hand winding of relay 562, over conductors 572, 573, 574, armature 544 and alternate contact of relay 521, conductor 519, ground at the right armature of relay 515. The current in this circuit sets up a magnetic field opposite in direction to that produced by the left hand winding of this relay. Consequently relay 562 does not operate at this time. Relays 609 and 605, however, operate, the former at its innermost right armature closing a locking circuit for itself as follows: free pole of battery, right winding and right innermost armature and front contact of relay 609, conductors 617, 641, 618 to ground at the armature 619 and front contact of slow relay 620, which latter relay operated upon the energization of the impulse relay 605. Relay 620 at its armature 619 grounds the sleeve wire 621 over conductor 618 to cause the multiples of this connector to test busy to the local second selectors.

The return of the dial to normal in transmitting the tens digit of the wanted number interrupts the circuit of relay 500, which in turn interrupts the circuit of relay 605, which in vibrating its armature transmits impulses to the vertical magnet 622 of the connector. The circuit for the first impulse is as follows: free pole of battery, magnet 622, slow relay 623, normal contact of the off-normal switch 624, lower armature and alternate contact of relay 620, armature and back contact of relay 605 to ground. At the first step of the connector, the off-normal switch 624 is shifted, and the succeeding impulses are transmitted by way of the upper armature and front contact of relay 623, conductor 628 and the contact 625, now closed, of the off-normal switch 624. Relay 626 is operated by its lower winding when relay 623 operates, its circuit including the lower armature and contact of relay 623, the innermost right armature of relay 609 and the ground at armature 619 of relay 620.

Relay 626 locks to the sleeve wire 604 in a circuit including conductor 601, and the armature 602 of relay 603. The connector brushes are thus elevated to the desired level, and upon the cessation of the impulses, relays 605 and 620 remain energized, and slow relay 623 in series with the vertical magnet releases, preparing the circuit of the rotary magnet 627. The return of the dial to normal in transmitting the units causes relay 605 to transmit impulses through the back contact of the relay 605, lower armature and alternate contact of relay 620, off-normal spring 625, conductor 628, upper armature and normal contact of relay 623, conductor 629, innermost left armature and normal contact of relay 630, conductor 631, uppermost armature and normal contact of relay 632, rotary magnet 627 to battery. The connector is thus stepped around into engagement with the desired line. If this line is idle, full potential is connected to its test multiple 633 from the line switch in the well-known manner, and the following circuit is closed to operate relay 632: battery, multiple 633, brush 635, conductors 636, 637, right armature and normal contact of relay 638, conductor 639, upper winding of relay 632, conductor 640, innermost right armature and normal contact of relay 630, conductors 641, 618 to ground at the armature 619 of relay 620. Relay 632 in attracting its armature 642, locks itself to grounded sleeve wire 604, and extends this grounded conductor over conductors 643, middle right armature and alternate contact of relay 609 to relay 603. Relay 603 operates and extends the talking conductors to the brushes of the connector to the wanted subscriber's loop and thus is also in this case a click indication transmitted to the operator to indicate that the connector has properly functioned. Relay 603 in attracting its armature 602, disconnects the grounded sleeve wire 604 from the conductor 600 leading back to the relay 516, Fig. 5, of the transmission selector. Relay 516 now retracts its outer left armature and operates relay 506, which reverses the current in the loop circuit leading back to the toll board including relay 500, and by including resistances 574, 575 in this loop reduces the strength of the current to such a value that the slow marginal relay 227 in the operator's telephone circuit releases, opening the circuit through the lower winding of relay 105. The operator will ordinarily after transmitting the last digit, restore the monitoring key 103, which opens the circuit through the upper winding of relay 105. Both circuits of relay 105 being now open, relay 105 therefore releases, and the calling supervisory relay 115 now operates over the following circuit in series with relay 500 to light the calling supervisory lamp 116 to indicate to the operator that the connector has seized the line

and that she may now depress her ringing key to cause the connector to apply ringing current to the selected line. The circuit for relays 500 and 115 is as follows: free pole of battery, left winding of relay 500, conductor 501, contact 502 of relay 503, resistance 574, left armature and alternate contact of relay 506, conductor 510, upper left winding of repeating coil 508, conductors 518, 426, multiple 425, brush 424, conductor 423, alternate contact and armature 422, of relay 406, conductors 419, 307, upper armature and alternate contact of relay 303, conductor 304, tip of the jack 300, tip of the plug 100, normal contact of relay 105, alternate contact of relay 101, normal contact of ringing key 118, conductor 119, right hand winding of impedance coil 109, armature and normal contact of relay 120, relay 115, left winding of impedance coil 109, conductor 121, normal contact of key 118, normal contact of relay 105, ring of the plug, ring of the jack, conductor 302, lower armature and alternate contact of relay 303, conductors 306, 420, armature 417 and alternate contact of relay 406, conductor 416, brush 415, multiple 414, conductors 427, 509, lower left winding of repeating coil 508, conductor 507, inner right armature and alternate contact of relay 506, resistance 575, conductor 577, right armature and normal contact 513 of relay 503, conductor 514 to ground through the right winding of relay 500. Relay 506 in attracting its outer right armature closes the following substitute circuit to ground to hold up the relay 626 before it can release, in order to prevent ringing from occurring at this time as would occur if this relay released: ground, left armature and normal contact of relay 578, conductor 579, outer left armature and normal contact of relay 503, outer right armature and alternate contact of relay 506, conductor 522, contact 545, armature 547 of relay 521, conductor 548, brush 549, multiple 550, control conductors 551, 600, armature 644 and front contact of relay 626, winding of relay 626 to battery. The operation of relay 603 by releasing relay 516 and operating relay 506 causes the reversal and reduction in the current flow in the loop leading back to the toll operator's position, opens the locking circuit of relay 626, and unless the substitute holding circuit described for holding up relay 626 is provided, the ringing operation will automatically take place, as will appear. This is prevented by supplying ground to the control conductor 600 at relay 578 over the circuit traced to hold up relay 626 until the operator, by depressing key 118 causes the release of relay 626 to start the ringing operation. The operator may now actuate ringing key 118, which impresses ringing current upon the talking conductors of the trunk to operate the alternating current relay 580 which operates relay 578. This relay, in attracting its outer left armature, opens the circuit heretofore traced which has been holding up relay 626. Relay 626 in retracting its armatures 645 and 659 connects ringing current to the subscriber's line A through its upper winding. This ringing current is intermittently applied until the called party removes his receiver, causing an increase in the current flowing in the upper winding of relay 626, whereupon it operates, removing the ringing current. Relay 626 in attracting its armature 644 again locks to the ground on control conductor 600. The extension of the tip and ring conductors to the subscriber's line by relay 626 operates relay 581 over which talking current is fed to the substation A. Relay 581 in attracting its armature operates relay 503 over a circuit including conductors 582, 583, inner left armature and normal contact of relay 578, conductor 584, inner left armature and normal contact of relay 585, relay 503 to battery. Relay 503 in attracting its outer left armature applied ground over the outer right armature and alternate contact of relay 506 and conductor 522 to control conductor 551 to hold slow relay 626 operated independently of the outer left armature and normal contact of relay 578. Relay 503 in opening its contacts 502 and 513 opens the connection of battery and ground through the windings of relay 500 to the talking conductors 509, 518, leading back to the toll operator's position, which causes the de-energization of the calling supervisory relay 115, which in releasing extinguishes supervisory lamp 116 to notify the operator that the subscriber has responded. Relay 503 in attracting its inner left armature closes a circuit to hold relay 500 energized, this circuit including resistance 586. Talking current is fed to the line A over the winding of relay 581 and the repeating coil 508. This talking circuit is a standard repeating coil transmission circuit used in long distance connections. Talking current is fed to the distant subscriber's line from the distant exchange in which the toll line 108 terminates. During conversation the trunk leading from the left hand windings of the repeating coil 508 through to the right hand windings of the repeating coil (not shown) at the distant office, is dry, in accordance with the standard practice. During the establishment of the connection, the subscriber at substation A by moving his switchhook up and down may cause the supervisory lamp 116 in the toll cord to flash, as in the case of manual telephone exchange practice, without releasing the switches. This is apparent from the preceding description inasmuch as relay 581 is in circuit with the line A, and each time it attracts its armature operates the relay 503, which removes battery and ground from the

trunk conductors leading back to the supervisory relay 115, and places a bridge across relay 500 to hold it operated to prevent release of the switches. When the party at substation A replaces his receiver, the lamp 116 lights at the operator's position as a disconnect signal.

The operator may re-ring the subscriber after he has replaced his receiver if she desires to recall him, by actuating the ringing key 118 thereby operating relay 580 to operate relay 578, which in attracting its outer left armature again releases slow relay 626, and initiates the automatic ringing connection at the connector. The control of the relay 626 was removed from the relay 578 by the attraction of the outer left armature of relay 503 when the subscriber at substation A responded and was restored to the relay 578 and consequently to the operator when the subscriber replaced the receiver and released relay 503.

When the operator desires to break down the connection after the subscriber at substation A has replaced his receiver, she removes the plug 100 from the toll jack 300. This releases relay 500, which causes the restoration of all the switches, as will be described. If, however, the operator removes the plug while the subscriber at substation A still has his receiver off the switchhook, relay 500 which controls the release of the switches is maintained energized over the circuit including resistance 586 due to the operated condition of relay 503.

Assuming, however, that the subscriber has replaced his receiver when the operator removes the plug, the relay 500 in releasing releases relay 515. Relay 515 in retracting its outer left armature removes ground from the sleeve conductor 588, leading back to the release relay 406, whereupon this relay closes the circuit of release magnet 412 of the incoming selector as follows: free pole of battery, magnet 412, contact of the off-normal switch 440, lower armature and normal contacts of relays 410, 400, uppermost armature and normal contact of relay 406 to ground. Removal of ground from the conductor 519 by the release of the right armature of relay 515 releases relay 521, and retraction of the right hand armature of relay 500 and the inner left armature of relay 515 closes the circuit of release magnet 589 of the transmission selector. The slow relay 530 is energized in parallel with the release magnet and opens the circuit to the test brush 535, during restoration. At its armature 590 relay 530 closes a locking circuit for itself, which is opened when the off-normal switch 527 assumes its normal position. The opening of the circuit of the tip and ring conductors causes the release of relays 605 and 620 of the connector, which results in the closure of the following

circuit for the connector release magnet 648: battery, magnet 648, left hand contact of off-normal switch 624, normal contacts of relays 607, 620 and 605 to ground. The connector, on reaching its normal position, restores the off-normal switch 624.

The withdrawal of the plug opened the locking circuit of relay 301 which in releasing relay 303 restored the trunk circuit of Fig. 3 to normal, and also released relays 101 and 131.

The current which flows back over the loop circuit from the machine switching office is necessarily of comparatively high potential in order to effectively operate the impulse relays to set the automatic switches and this current must be cut down in strength by the inclusion of suitable resistances 574 and 575 at the toll transmission selector before being allowed to flow into the cord to operate the relay 115 which is bridged across the toll cord in series with the impedance coil 109. Coil 109 must be of high impedance to prevent the supervisory relay bridge from shunting the voice currents, and is so constructed that excessive currents such as must be used for operating the impulse relays would permanently impair its efficiency by adversely affecting its magnetic characteristics.

If the operator, after having turned the dial for the last digit, restores the monitoring key, but relay 506 is not operated to reverse the current in the trunk and insert the resistances 574 and 575 in the loop circuit, marginal relay 227 does not release. Consequently the circuit through the lower winding of relay 105 is maintained closed even though the operator restores the monitoring key 103 and opens the circuit through the upper winding. Restoration of the monitoring key opens the circuit of relay 215, which in retracting its left armature closes the circuit of lamp 236, which lights since relay 235 is operated due to the energized condition of marginal relay 227. The lighting of the lamp 236 indicates trouble to the operator, whereupon she removes the plug from the jack and inserts it into the jack of another trunk and again operates the dial to transmit the digits of the desired number.

If the operator does not restore the monitoring key after having transmitted the last digit, the relay 506 in reversing the current flowing in the loop circuit, operates polarized relay 230, which in turn operates relay 240. Relay 240 closes the following circuit for the calling supervisory relay 115 to light the lamp 116: free pole of battery, resistance 241, conductor 242, upper armature and alternate contact of relay 240, upper left winding of induction coil 231, conductor 243, upper armature and alternate contact of relay 219, conductors 244, 245,

alternate contact of key 103, conductor 123, normal contacts of key 124, conductor 119, right winding of coil 109, normal contact of relay 120, relay 115, left winding of coil 109, normal contacts of key 124, alternate contact of key 103, conductors 126, 246, 247, lower armature and alternate contact of relay 219, conductor 228, lower left winding of induction coil 231, lower armature and alternate contact of relay 240, resistance 249, ground. The lighting of this lamp gives the operator the ringing signal. She may now restore the key 103, opening the circuit through the upper winding of relay 105, which thereupon releases, since the circuit through the lower winding is now open at the armature of relay 227. The circuit for the relay 115 now leads over the circuit traced including the normal contacts of relay 105 and the plug 100.

Key 125 is the operator's talking and listening key. The actuation of this key bridges the transmitter circuit 260 across the toll cord in addition to connecting the receiver 200 to the cord so that the operator can converse with the subscriber or with the distant toll operator. The monitoring key 103 in addition to controlling the connection of the dial to the cord circuit, is used to permit the operator to listen in on long distance connections without unbalancing the circuits, in accordance with the well-known practice.

Assuming now that the desired line when selected by the connector is busy, the test multiple 633, Fig. 6, is grounded. When test wiper 635 is set on the busy multiple 633, a connection is extended from ground over brush 635, conductor 636, conductor 637, right armature and front contact of relay 638, conductor 649, armature 650 and back contact of relay 632, conductor 651, relay 630 to battery. Relay 630 energizes, and when slow relay 638 releases a slight interval after the last units impulse is transmitted, locks itself up over the following circuit: free pole of battery, relay 630, conductor 651, armature 650 and normal contact of relay 632, conductor 649, right normal contact of relay 638, conductor 652, right armature and alternate contact of relay 630, conductors 641, 618, to grounded armature 619 of relay 620. Relay 630, in attracting its right armature due to the line being busy, prevents test relay 632 from operating when slow relay 638 releases. When relay 630 operates, a circuit is closed for relay 607 from battery, upper winding of relay 607, conductor 654, upper normal contact of relay 603, conductors 655, 656, resistance 660, outer left normal contact of relay 638, outer left armature and front contact of relay 630, inner right armature and front contact of relay 609, conductors 617, 641, 618 to grounded armature 619. Relay 607 reverses the direc-

tion of current flow through the left winding of relay 562, Fig. 5, which results in this relay operating. Relay 562, attracting its inner left armature, operates relay 506, the circuit being as follows: battery, relay 506, conductor 591, inner left armature and alternate contact of relay 562, conductors 573, 574, armature 544 and alternate contact of relay 521 to ground at the right armature and alternate contact of relay 515. Relay 506 reverses the direction of current flow in the loop leading back to the toll office, and also includes the resistances 574 and 575 in this loop to reduce the current strength. Due to the reduction in current strength, marginal relay 227 in the operator's circuit releases as described, and assuming the operator has restored her dialing key 103, relay 105 releases, connecting the calling supervisory relay 115 to the plug 100 and thence to the trunk. Relay 562 in attracting its right armature closes a circuit for relay 578, this circuit including the outer right armature and alternate contact of relay 516 and the right armature and alternate contact of relay 500. Relay 578 in attracting its inner left armature connects an interrupter 592 in circuit with relay 503, this circuit including conductor 584 and the inner left armature and normal contact of relay 585. Relay 503 thereupon at contacts 502, 513, intermittently removes battery from the loop leading back to the toll board, resulting in the intermittent operation of the calling supervisory relay 115, which flashes the lamp 116, preferably at the rate of 120 flashes per minute, thus indicating to the toll operator that the desired line is busy. Relay 562 in attracting its outer left armature, prepared a circuit for applying busy tone to the trunk leading back to the toll board, this circuit being closed at the outer left armature of relay 578 to apply the tone current. This circuit is as follows: outer left armatures and alternate contacts of relays 578 and 562, secondary of the tone coil 593, condenser 594, conductor 595, left armature and alternate contact of relay 500, conductor 596, armature 556 and normal contact of relay 557, conductor 558, lower right winding of repeating coil 508, resistance 559, conductor 560, inner left armature and alternate contact of relay 516, conductor 561, left winding of relay 562, conductors 563, 564, resistance 565, upper right winding of repeating coil 508, conductor 566, upper normal contact of relay 557, conductor 567, upper alternate contact of relay 521, conductor 568, brush 542, multiple 569, conductors 570, 614, upper normal contact of relay 603, conductor 615, upper alternate contact of relay 607, to battery through the upper winding of relay 605. The repeating coil 508 transmits this tone by induction over the trunk circuit, through the toll cord

to the toll line 108 and thence to the head set of the distant toll operator.

If the dialing key is still actuated, relay 105 does not release, and the tone circuit for the toll operator at whose position the toll cord of Fig. 1 is located includes alternate contacts of relays 105 and 222 and the right windings of induction coil 231. This tone is transmitted by induction through the left windings of the induction coil 231, the alternate contacts of relays 219 and 203 to the operator's receiver 200. This tone is transmitted to the distant toll operator's head set by induction through the windings of the induction coil 231, alternate contacts of relay 219, conductors 244, 247, conductors 245, 246, alternate contacts of the monitoring key 103 to the tip and ring conductors of the toll cord, tip and ring conductors of the plug 128, tip and ring conductors of the trunk 108, over the toll line to the distant office and thence to the distant operator's head set. The intermittent operation of relay 503 in removing current from the loop leading back to the toll cord, after the relay 506 has operated to reverse the current, will cause the intermittent operation of polarized relay 230 to intermittently operate relay 240. Relay 240 thereupon applies and removes battery through resistances 241 and 249, conductors 243 and 228 and alternate contacts of relay 219 and alternate contacts of monitoring key 103 to the calling supervisory relay 115 to flash the calling supervisory lamp 116.

Thus it will be seen that if the operator has restored the monitoring key 103, after dialing the wanted number and the connector finds the line busy, she will get a flashing signal from the calling supervisory lamp 116 to indicate that the line is busy, and the distant toll operator will get a tone. If the operator has not restored the key, she will get this flashing signal, and in addition a tone in her head set to indicate the busy condition; and the distant toll operator will get a tone, thus avoiding the necessity of having to be informed that the desired line is busy by the toll operator who is setting the automatic switches.

If in building up a connection the incoming selector, Fig. 4, or the toll transmission selector, Fig. 5, encounters a busy trunk group, a circuit change is brought about to cause the flashing of the calling supervisory lamp 116 in the operator's toll cord at a rate different from that caused by finding the desired line busy. Referring to Fig. 4, this is brought about in the following manner: if the incoming selector fails to find an idle trunk in the selected group, switch 401 is operated by the shaft on its eleventh step closing a circuit for relay 404. Relay 404 causes the current in the trunk leading back to the toll board to be reversed in

direction. The reversal in the direction of the current flow, operates the polarized relay 230 in the operator's circuit, operating relay 240, which applies current as described through alternate contacts of the dialing key 103 to the calling supervisory relay 115. The operation of relay 404 at its lowermost armature contact connects the interrupter 430 to the relay 408 which interrupts the loop circuit and causes relay 230 to intermittently operate relay 240 to apply and remove battery from the relay 115 through the circuit including the alternate contacts of the key 103, thus flashing the lamp 116 to indicate the all trunks busy condition. Interrupter 430 is arranged to operate relay 408 to flash lamp 116 at the rate of 60 flashes per minute, to differentiate from the line busy flashing signal.

It will be noted that relay 214 releases between swings of the dial to remove the short circuit from about polarized relay 230 to include this relay in the loop circuit leading to the switches in order to permit this relay to bring about the flashing of the calling supervisory lamp 116 between digits if a busy trunk group is encountered. More in detail, when the switch 401 operates on the eleventh rotary step of the incoming selector, it energizes relay 404. Relay 404 reverses the connections of the conductors 419, 420 with the relay 400, and includes the resistances 431 and 432 in the loop circuit leading back to the toll board. This circuit may now be traced as follows: battery, lower winding of relay 400, conductor 409, normal contact of relay 408, conductor 433, resistance 431, alternate contact of relay 404, conductor 405 of the trunk conductor 419 by way of armature 422 of relay 406, over the loop circuit leading back to the toll board and including alternate contacts of relays 105 and 222, and polarized relay 230, and returning by way of trunk conductor 420, armature 417 and normal contact of relay 406, conductor 407, lower inner alternate contact of relay 404, resistance 432, conductor 403, upper winding of relay 400, conductor 434, upper outer alternate contact of relay 404, secondary of tone coil 435, to ground. Relay 404 in operating also connects interrupter 430 to relay 408. Relay 408 intermittently opens the loop circuit traced including the polarized relay 230, which in operating relay 240 flashes the calling supervisory lamp 116 at the rate of 60 flashes per minute. Tone from the source 435 is also applied to the loop circuit and is transmitted to the receiver 200 of the toll operator's head set, this tone being different from that produced by source 593 described in the case of a busy subscriber's line. Induction coil 231 transmits this tone through the alternate contacts of relay 219 and conductors 245 and 246, and alternate contacts

of the monitoring key 103 to the toll line 108, and thence to the distant operator to notify her that one of the desired trunk groups is busy.

5 In case the toll transmission selector, Fig. 5, encounters the desired trunk group busy, switch 539 is operated on the eleventh rotary step of the selector, operating relay 585, this circuit including the right armature and alternate contact of relay 500. Relay 585 in
10 attracting its outer left armature operates relay 506 over conductors 598 and 591. Relay 506 as described reverses the direction of the current flowing in the loop leading back to the toll board. Relay 585 at its inner left armature intermittently operates relay 503 to
15 close a bridge including resistance 586 across the windings of relay 500 to hold this relay and consequently slow relay 515 operated to prevent release of the switches and applies and removes battery from the loop leading back to the toll board to intermittently operate calling supervisory relay 115 to flash the
20 calling supervisory lamp 116 at the rate of 60 flashes per minute to indicate an all trunks busy condition. As in the case of the incoming selector, tone is applied from ground, condenser 599, secondary of the tone coil 576, over the right armature and alternate contact of relay 585, conductor 595, left alternate contact of relay 500, to the lower talking conductor, right lower winding of repeating coil 508, resistance 559, conductor 560, to battery through the winding of relay
30 581. This tone is repeated in the loop circuit as described by the repeating coil 508 and is transmitted by the induction coil 231 to the operator's receiver 200, and also through alternate contacts of key 103 to the toll line 108, and thence to the distant toll line operator.

When the operator receives an all trunks busy signal, she withdraws the plug 100 from the jack 300 which causes the release of the
45 switches as described in the case of a successful connection, and attempts to set up the connection later.

Referring now to Fig. 3^a, this view shows a toll switching trunk leading to a machine switching office which may terminate thereat in an incoming selector, similar to that shown in Fig. 4. This trunk is equipped with what is known as "delayed release equipment", which enables the toll operator to change cords without releasing the automatic switches even though the subscriber at substation A has replaced his receiver, it being remembered that if he has not replaced his receiver and the operator disconnects, the switches are held up due to the relay 500 being held operated.

In building up a connection over the trunk shown in Fig. 3^a, the operator inserts the plug 100 in jack 310, whereupon relay 311
65 operates in series with relays 131 and 101.

Battery on the sleeve of plug 100 causes multiples of this trunk to test busy to other toll operators. Relay 311 in attracting its inner right armature opens a bridge across the trunk conductors 321, 313 including a relay 314 to prevent interference with the transmission of the impulses. Battery applied to the tip and ring of the cord operates relay 315, just as in the case of relay 301, Fig. 3. Relay 315 at its right armature locks over
75 its right winding to ground through normal contacts of relays 316 and 317, this circuit including relay 318. Relay 318 at its armature 350 prepares a circuit for relay 323. Relay 318 extends the loop circuit including the impulse contacts of the operator's dial to the trunk conductors 319 and 320 leading to the machine switching office and terminating thereat in an incoming selector such as shown in Fig. 4. The operations involved
85 in building up the connection to the desired subscriber's line and the operation of the switches in case they find a desired trunk group busy or the desired line busy or idle is exactly the same as that described in connection with Fig. 3.

Considering first the normal operation of the trunk circuit, that is, the restoration of its equipment after the party at station A has replaced his receiver, the removal of the plug 100 from the jack 310 releases relay 311 which in retracting its inner right-hand armature closes a bridge including relay 314 across the outgoing trunk conductors 312 and 313 to hold up relay 500 to prevent premature release of the switches. Relay 311 in retracting its left armature connects battery through resistance 321 and the left armature of relay 315 to the sleeve multiples of the jacks to cause the trunk
105 to test busy to other toll operators. Relay 311 will not operate when this circuit is closed due to the presence of resistance 321. The retraction of the outer right armature of relay 311 operates relay 323, the circuit including armature 350 of relay 318. Relay 323 locks over its right winding to the inner left armature and normal contact of relay 317. When the metallic segment of interrupter 322 engages the interrupter brush, relay 316 operates over a circuit including the outer left normal contact of relay 317, normal contact of relay 316 and the outer right-hand armature and alternate contact of relay 323. In attracting its outer right-hand armature, relay 316 closes a holding circuit for relays 315 and 318 to prevent premature release of the switches and at its inner right-hand armature closes a circuit including its own winding and the right winding of relay 317, relay 326 and interrupter 324, the brush of which is at this time riding on the metallic segment thereof. Relay 317 at its inner left-hand armature closes a locking circuit for itself to battery
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at the outer right-hand armature of relay 323. When the interrupter 324 advances until its brush engages its insulating segment it opens the circuit including relay 316 and the right winding of relay 317. Relay 316 in releasing its outer right-hand armature releases relays 315 and 318, since relays 317 and 314 are at this time operated. Relay 318 in releasing opens the circuit including relay 500 which causes the release of the switches. Relay 318 in retracting its armature 350 opens the circuit including the left winding of the relay 323.

If before the brush of the interrupter 324 engages the insulating segment which may be approximately three seconds after the operator has removed the plug, she inserts another plug in the jack 310, relay 311 again operates. In attracting its inner right armature it opens the loop circuit including the relay 314 and closes a substitute circuit therefor through the jack and plug and including the calling supervisory relay bridge to hold up the relay 500. Relay 311 in attracting its outer right armature opens the circuit through the left winding of relay 323. When the interrupter 322 operates relay 316, its outer right armature applies a substitute ground to hold up relays 315, 318 as before but when interrupter 324 opens the circuit of relays 316, 317, relays 315, 318 are held operated from ground on conductor 328 applied over the outer right armature of relay 311, the right alternate contact of relay 317 and the continuity contact 329 of relay 316, and when relay 317 releases the ground applied at the continuity contact 330 of relay 317 restores the original circuit of relays 318, 315. Due to the inert condition of relay 323 relay 316 is not operated the next time the brush of the interrupter 322 engages the metallic segments thereof.

Relay 323 is provided to prevent premature release of the switches due to a momentary energization of relay 311 while the operator is inserting the plug. This may occur due to contact being made between the sleeves of the plug and jack before the plug has been inserted far enough for the tips of the plug and jack to register. The tips and rings respectively of the plug and jack must engage to provide a holding circuit including the cord for relay 500 before relay 311 opens the bridge containing relay 314, to prevent premature release. Relay 323 it will be remembered is energized immediately upon the withdrawal of the plug and at its left armature closes a shunt about the inner right armature and normal contact of relay 311 thus providing a substitute bridge to hold relay 500 operated. Relay 323 is not released, it will be remembered, until the release of relay 316 at the expiration of the time interval, and until relay

318 releases. Interrupters 322 and 324 may be common to a number of the trunks of the toll board which lead to machine switching offices. Relay 326, located in the common lead to interrupter 324, is provided to disconnect interrupter 322 from the relays 316 of the other trunks to prevent interference.

Referring to Fig. 2, marginal relay 210 in the common lead 209 is provided to light a lamp 255 in case the operator inserts the plug of another cord into a jack and actuates the dialing key 103 of this cord without releasing the dialing key of the cord first used. Relay 210 in addition to lighting lamp 255, short circuits the impulse contacts of the dial to prevent impulses being transmitted to the first cord in case the operator does not notice the lighted lamp in time and turns the dial.

What is claimed is:

1. In a telephone system, a toll line, a toll cord circuit, a visual signaling device associated therewith, a toll switching trunk, automatic switches, trunk groups terminating therein, a sender for setting said switches, and means automatically operated when one of said switches encounters a busy trunk group for operating said signaling device and for transmitting a signal to said toll line.
2. In a telephone system, a toll line, a toll cord circuit, a visual signaling device associated therewith, automatic switches including a connector, trunk groups terminating in certain of said automatic switches, a sender for setting said switches, and means automatically operated when one of said switches encounters a busy trunk group or when the connector finds the desired line busy for operating said signaling device and for transmitting a signal to said toll line.
3. In a telephone system, a toll line, a toll cord circuit, a supervisory lamp associated therewith, automatic switches, trunk groups terminating therein, a sender for setting said switches, and means automatically operated when one of said switches encounters a busy trunk group for flashing said lamp and for transmitting a signal to said toll line.
4. In a telephone system, telephone lines, automatic switches, a sender, a connecting circuit, a supervisory relay connected to the calling end thereof, a manual switch adapted when actuated to cause the disconnection of said relay from the calling end of said connecting circuit and to connect said sender thereto to set said switches, and a circuit for operating said relay including the answering end of said connecting circuit and operated contacts of said manual switch.
5. In a telephone system, an operator's position, a sender thereat, a trunk extending from said position and terminating in an

automatic switch, other automatic switches, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay associated therewith, a signal controlled thereby, means including a manual switch adapted when actuated to cause the disconnection of the calling plug of said cord from said relay, and for transferring the calling plug into connection with said sender, and a circuit closed when one of said switches encounters a busy trunk group for actuating said relay to operate said signal irrespective of the position of said manual switch.

6. In a telephone system, an operator's position, a sender thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay associated therewith, a lamp controlled thereby, a switching relay adapted when operated to disconnect the calling plug of the cord from said supervisory relay and to transfer the calling plug into connection with said sender and when released to restore the continuity of said cord, a manual switch, a circuit for said switching relay controlled by said manual switch, a circuit closed when one of said switches encounters a busy trunk for actuating said supervisory relay, said circuit including alternate contacts of said switching relay, contacts of the actuated manual switch and the answering end of said cord, and a second circuit for said supervisory relay closed when one of said switches encounters a busy trunk group and the manual switch has been restored, said circuit including normal contacts of said switching relay and the calling end of said cord.

7. In a telephone system, an operator's position, a sender thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay, a lamp controlled thereby, means including a manual switch adapted when actuated to disconnect the calling plug of said cord from said relay and to transfer the calling plug into connection with said sender, and a circuit closed when one of said switches encounters a busy subscriber's line for actuating said relay irrespective of the position of said manual switch.

8. In a telephone system, an operator's position, a sender thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay associated therewith, a switching relay adapted when operated to

disconnect the calling plug of the cord from said supervisory relay and to transfer the calling plug into connection with said dial and when released to restore the continuity of said cord, a key, a circuit for said switching relay controlled by said key, a circuit closed when one of said switches encounters a busy trunk group for actuating said supervisory relay, said circuit including alternate contacts of said switching relay, contacts of the actuated key and the answering end of said cord, and a second circuit for said supervisory relay closed when one of said switches encounters a busy subscriber's line and the key has been restored, said circuit including normal contacts of said switching relay and the calling end of said cord.

9. In a telephone system, an operator's position, a dial thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay associated therewith, a switching relay adapted when operated to disconnect the calling plug of the cord from said supervisory relay and to transfer the calling plug into connection with said dial and when released to restore the continuity of said cord, a key, a circuit for said switching relay controlled by said key, a locking circuit for said switching relay for holding the same operated when the key is released, a marginal relay controlling said circuit at an alternate contact, a circuit for said marginal relay including a resistance, means for automatically including said resistance in circuit with said marginal relay when one of said switches encounters a busy trunk group to cause said marginal relay to release said switching relay to disconnect the dial from the calling plug and extend the same to said supervisory relay, a lamp controlled thereby, and means operated by said switch to operate the supervisory relay to flash said lamp in a characteristic manner.

10. In a telephone system, an operator's position, a dial thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches including a connector, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay associated therewith, a switching relay adapted when operated to disconnect the calling plug of the cord from said supervisory relay and to transfer the calling plug into connection with said dial and when released to restore the continuity of said cord, a key, a circuit for said switching relay controlled by said key, a locking circuit for said switching relay for holding the same operated when the key is released, a marginal relay controlling said circuit at an alternate contact,

a circuit for said marginal relay including a resistance, means for automatically including said resistance in circuit with said marginal relay when said connector is set on a busy line to cause said marginal relay to release said switching relay to disconnect the dial from the calling plug and extend the same to said supervisory relay, a lamp controlled thereby, and means operated by said connector to operate said relay to flash said lamp in a characteristic manner.

11. In a telephone system, telephone lines, a connecting circuit, a sender associated therewith, automatic switches adapted to be set under control of said sender to interconnect said lines, trunk groups terminating in certain of said switches, a visual signaling device and an audible signaling device associated with said connecting circuit, and means controlled by the busy condition of a selected trunk group for operating both of said devices.

12. In a telephone system, telephone lines, a cord circuit, a sender associated therewith, automatic switches adapted to be set under control of said sender to interconnect said lines, trunk groups terminating in certain of said switches, a supervisory lamp in said cord circuit, an operator's receiver adapted to be associated with said cord circuit, and means controlled by the busy condition of a selected trunk group for flashing said lamp and transmitting a tone to said telephone receiver.

13. In a telephone system, an operator's position, a dial thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches including a connector, a cord circuit, a supervisory relay and an impedance coil in bridge thereof, a supervisory signal controlled thereby, a switching relay adapted when operated to disconnect the calling plug of the cord from said supervisory relay and to transfer the calling plug into connection with said dial and when released to restore the continuity of said cord, means controlled by the operator for energizing said switching relay, resistances adapted to be included in said trunk circuit, means actuated when said connector finds the called line idle for including said resistances in said trunk, a relay responsive only to the inclusion of said resistances and adapted to deenergize said switching relay, and a circuit including said resistances and said supervisory relay closed by the release of said switching relay whereby said relay operates said signal.

14. In a telephone system, a toll line, a toll cord circuit, a supervisory lamp associated therewith, automatic switches including a connector, trunk groups terminating in certain of said automatic switches, a sender for setting said switches, means automatically operated when one of said

switches encounters a busy trunk group for flashing said lamp in one manner and for transmitting a signal of one character to said toll line, and means automatically operated when said connector finds the desired subscriber's line busy for flashing said lamp in another manner and for transmitting a signal of another character to said toll line.

15. In a telephone system, a toll line, a toll cord circuit, a supervisory lamp associated therewith, automatic switches including a connector, trunk groups terminating in certain of said automatic switches, a sender for setting said switches, means automatically operated when one of said switches encounters a busy trunk group for flashing said lamp in one manner and for transmitting a signal of one character to said toll line, means automatically operated when said connector finds the desired subscriber's line busy for flashing said lamp in another manner and for transmitting a signal of a different character to said toll line, and means automatically operated when the desired line is found to be idle for lighting said lamp as a ringing signal to the toll operator.

16. In a telephone system, a toll line, a toll cord circuit, a supervisory lamp associated therewith, automatic switches including a connector, trunk groups terminating in certain of said automatic switches, a sender for setting said switches, means automatically operated when one of said switches encounters a busy line for flashing said lamp in one manner and for transmitting a signal of one character to said toll line, means automatically operated when the desired line is found to be idle for lighting said lamp as a ringing signal to the toll operator, a key controlled by the toll operator for causing said connector to apply ringing current to the selected line, and means controlled by the called party in responding for extinguishing said lamp.

17. In a telephone system, an operator's position, a dial thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay associated therewith, a switching relay adapted when operated to disconnect the calling plug of the cord from said supervisory relay and to transfer the calling plug into connection with said dial and when released to restore the continuity of said cord, a key, a circuit for said switching relay controlled by said key, a locking circuit for said switching relay for holding the same operated when the key is released, a marginal relay controlling said circuit at an alternate contact, a circuit for said marginal relay including a resistance, means for automatically including said resistance in

circuit with said marginal relay when one of said switches encounters a busy trunk group to cause said marginal relay to open the locking circuit of said switching relay, a signal, a circuit therefor prepared by the operation of said marginal relay, and a relay for maintaining said signal circuit open while said key is operated, said relay being released when said key is released to close said signal circuit if said marginal relay has not been released by the inclusion of said resistances.

18. In a telephone system, an operator's position, a dial thereat, a trunk extending from said position and terminating in an automatic switch, other automatic switches, groups of trunks terminating therein, a cord circuit for connection to said trunk, a supervisory relay associated therewith, a switching relay adapted when operated to disconnect the calling plug of the cord from said supervisory relay and to transfer the calling plug into connection with said dial and when released to restore the continuity of said

cord, a key, a circuit for said switching relay controlled by said key, a locking circuit for said switching relay for holding the same operated when the key is released, a marginal relay controlling said circuit at an alternate contact, a circuit for said marginal relay including a resistance, means for automatically including said resistance in circuit with said marginal relay when the connector is set on the called line to cause said marginal relay to open the locking circuit of said switching relay, a signal, a circuit therefor prepared by the operation of said marginal relay and a relay for maintaining said signal circuit open while said key is operated, said relay being released when said key is released to close said signal circuit if said marginal relay has not been released by the inclusion of said resistances.

In testimony whereof, I have signed my name to this specification this 3rd day of April 1922.

JOHN F. TOOMEY.