Jan. 11, 1927. 1,613,624

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MACHINE SWITCHING TELEPHONE EXCHANGE SYSTEM

Original Filed Sept. 25, 1920 9 Sheets-Sheet 1

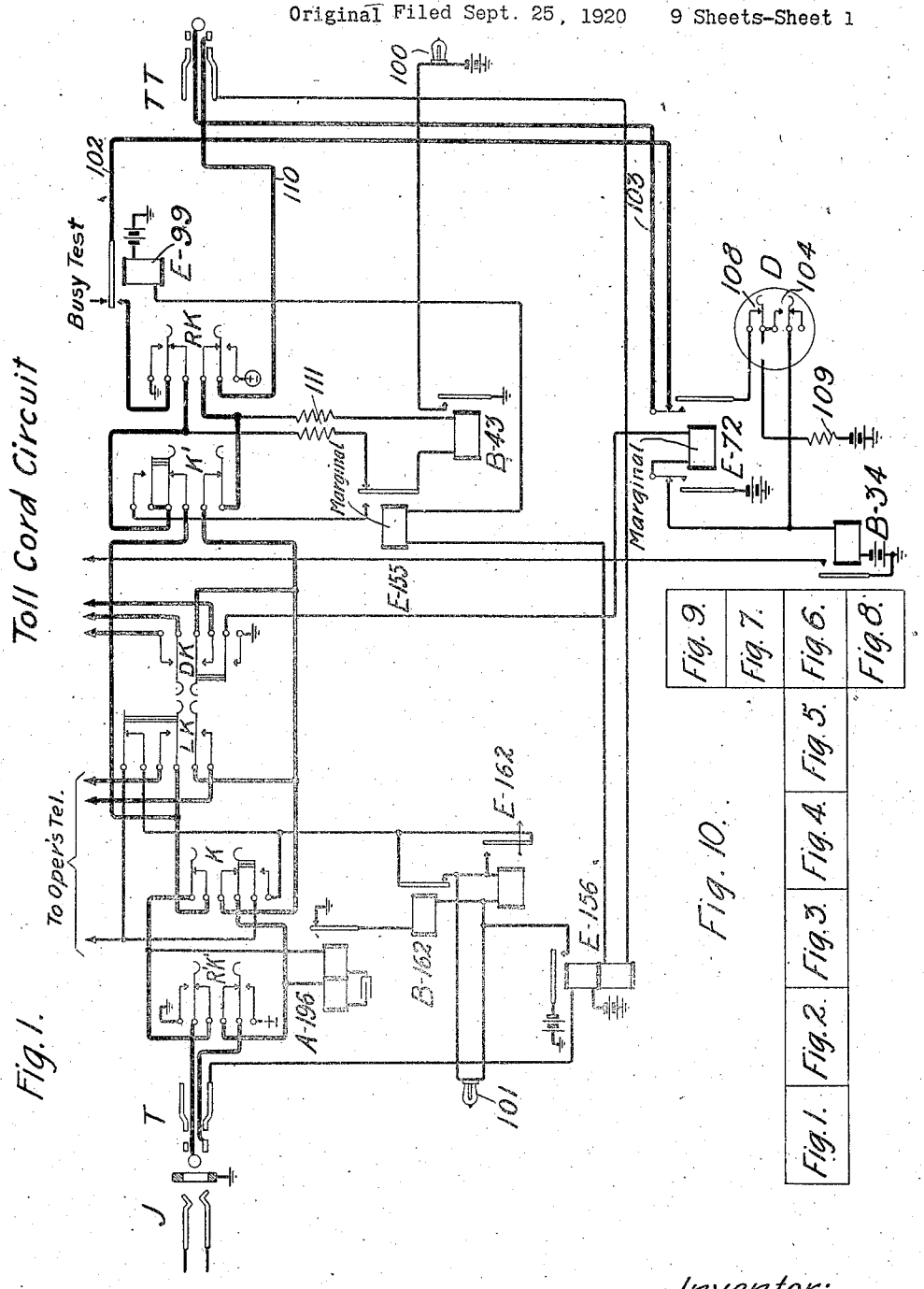

Fig. 1.

Fig. 9.	Fig. 7.	Fig. 6.	Fig. 8.
		Fig. 5.	
		Fig. 4.	
		Fig. 3.	
		Fig. 2.	
		Fig. 1.	

Fig. 10.

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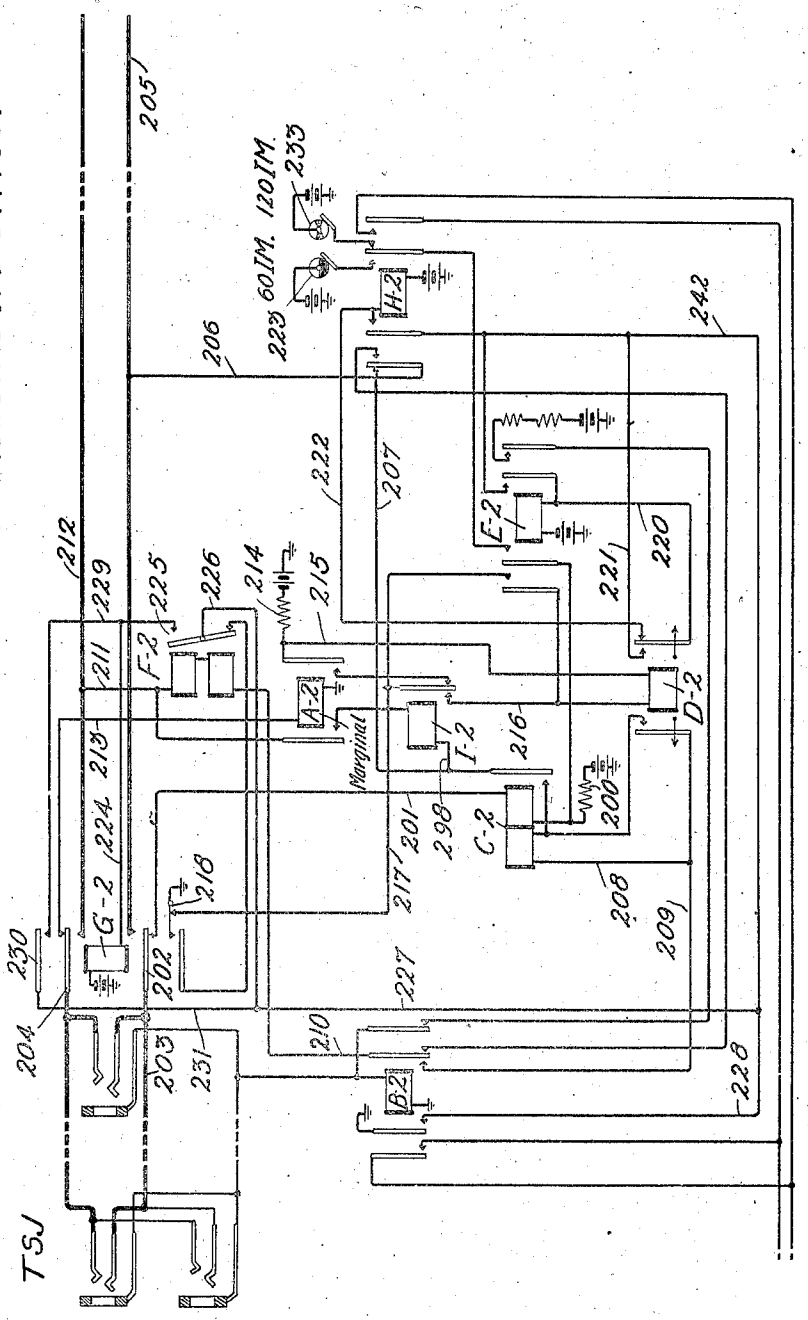
Fig. 2. Trunk Outgoing from Toll-Board to Automatic Office.



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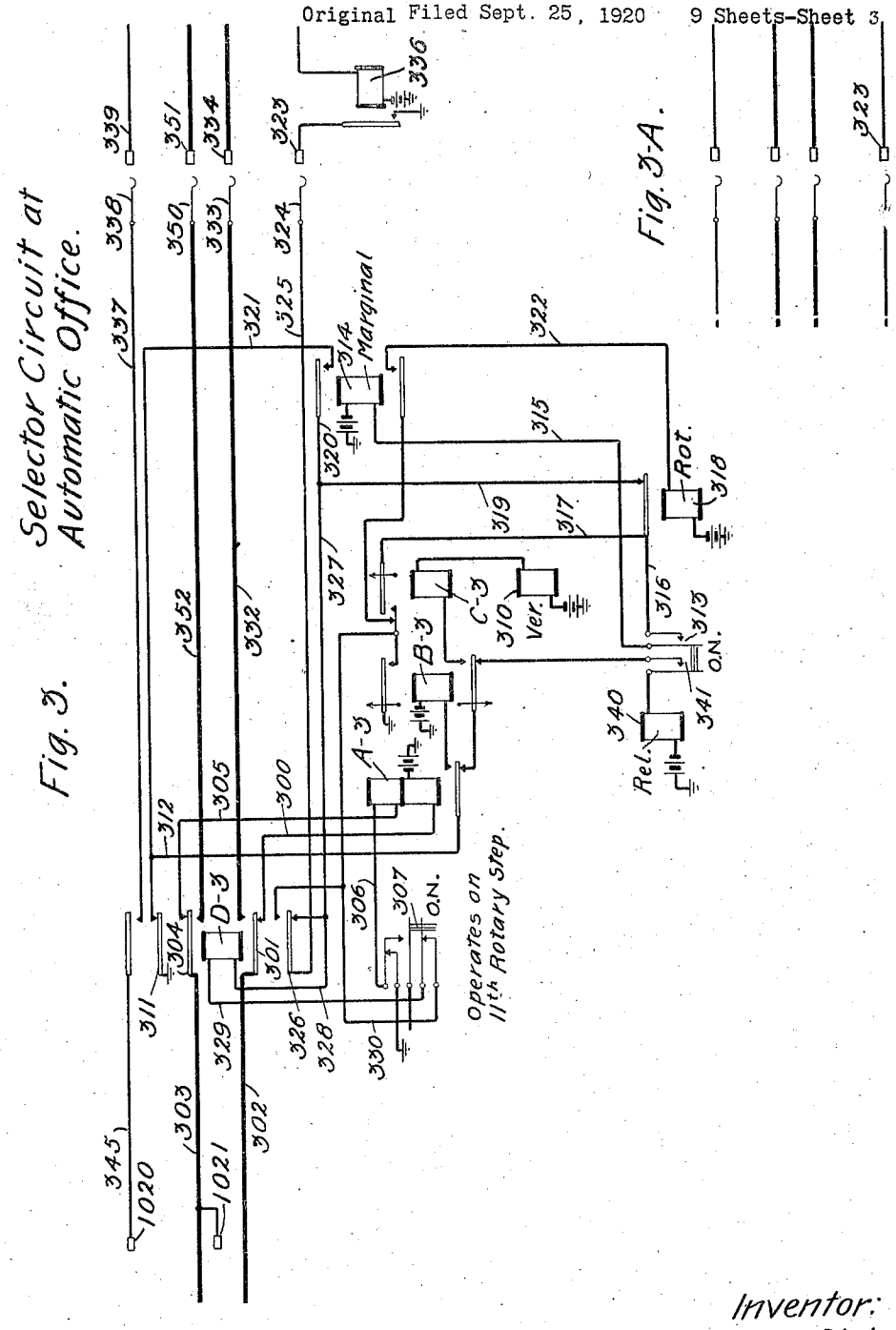
MACHINE SWITCHING TELEPHONE EXCHANGE SYSTEM

Original Filed Sept. 25, 1920 9 Sheets-Sheet 3



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Original Filed Sept. 25, 1920 9 Sheets-Sheet 4

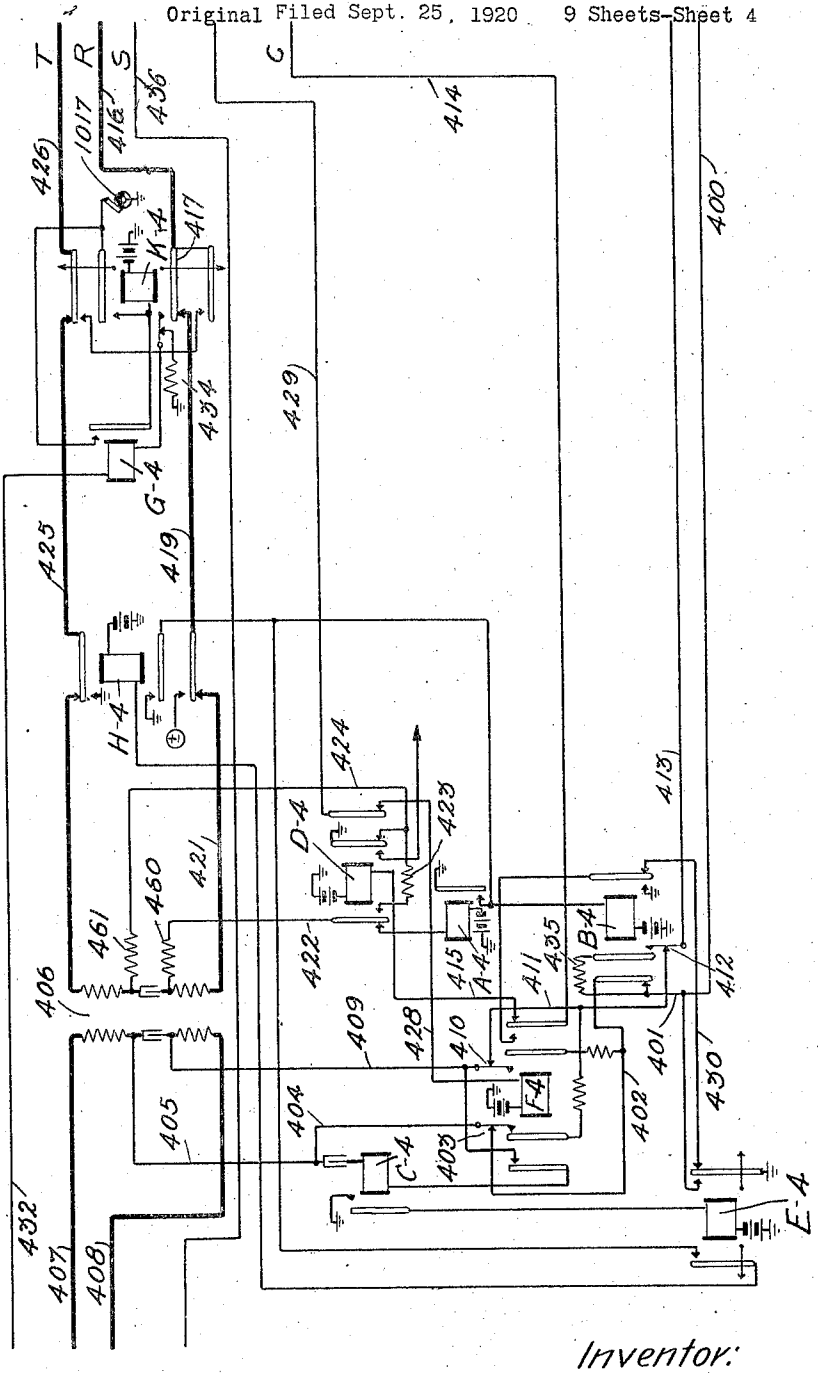

Fig. 4.

Relay and Repeating Coil Equipment.

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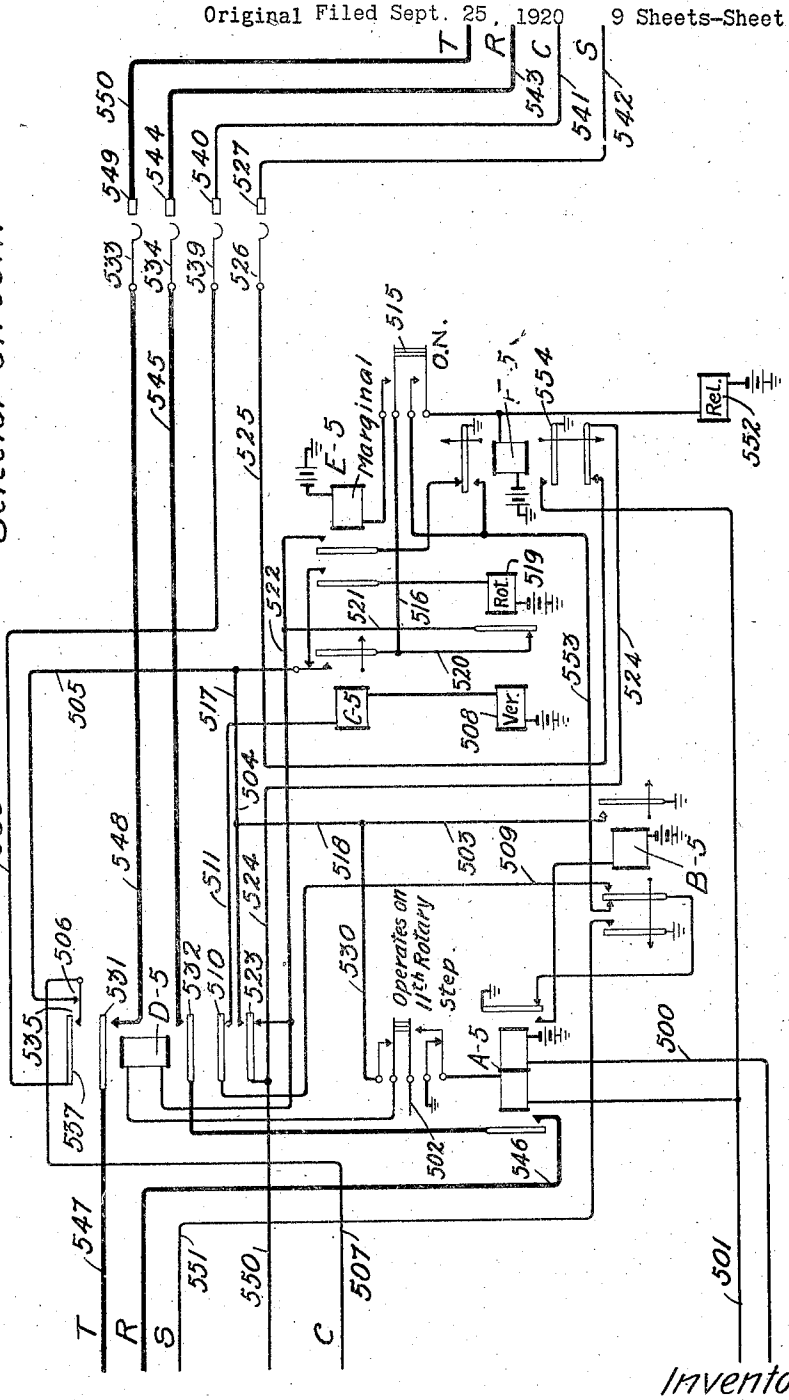
Fig. 5. Toll Transmission Selector Circuit.



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MACHINE SWITCHING TELEPHONE EXCHANGE SYSTEM

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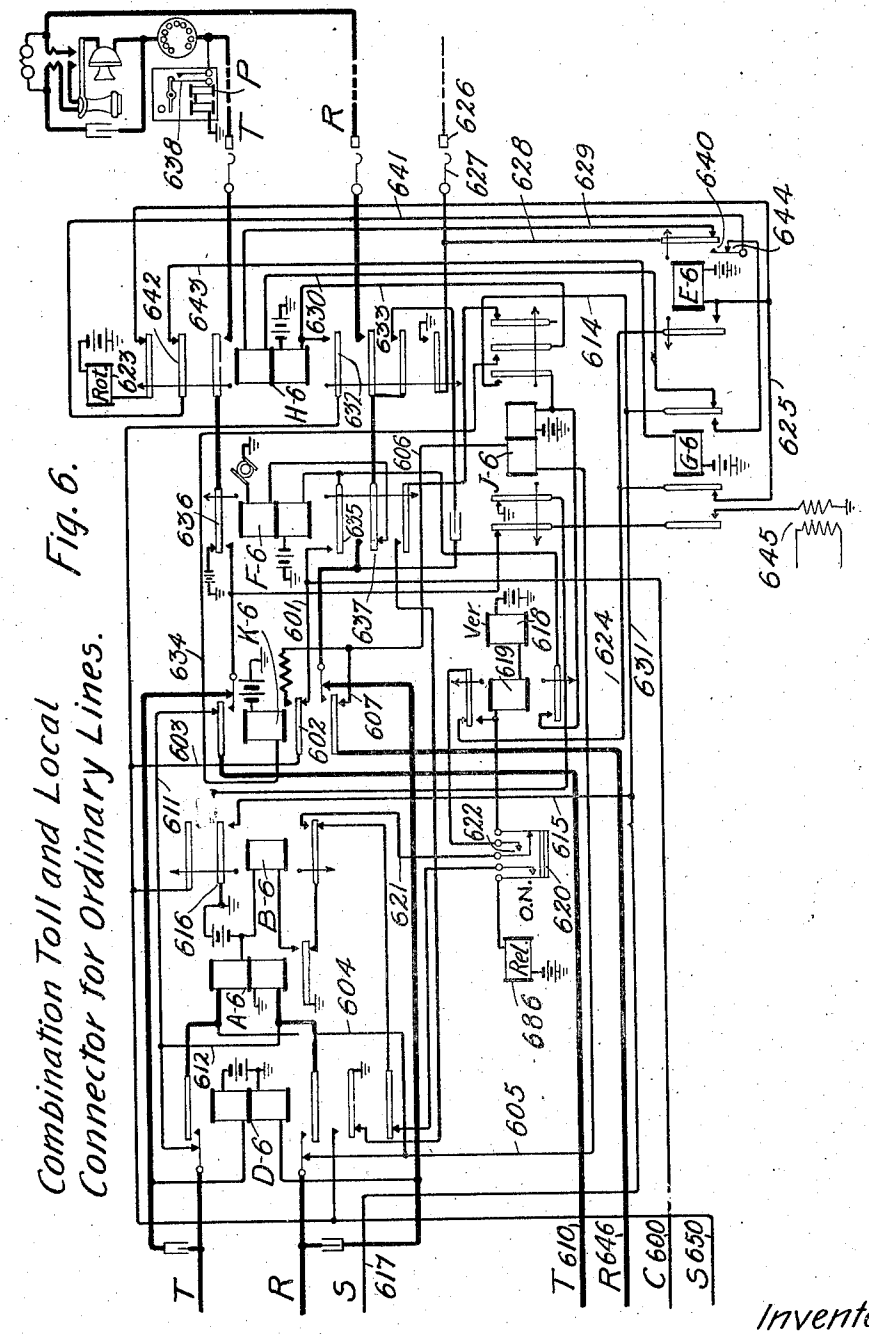

Fig. 6.

Combination Toll and Local Connector for Ordinary Lines.

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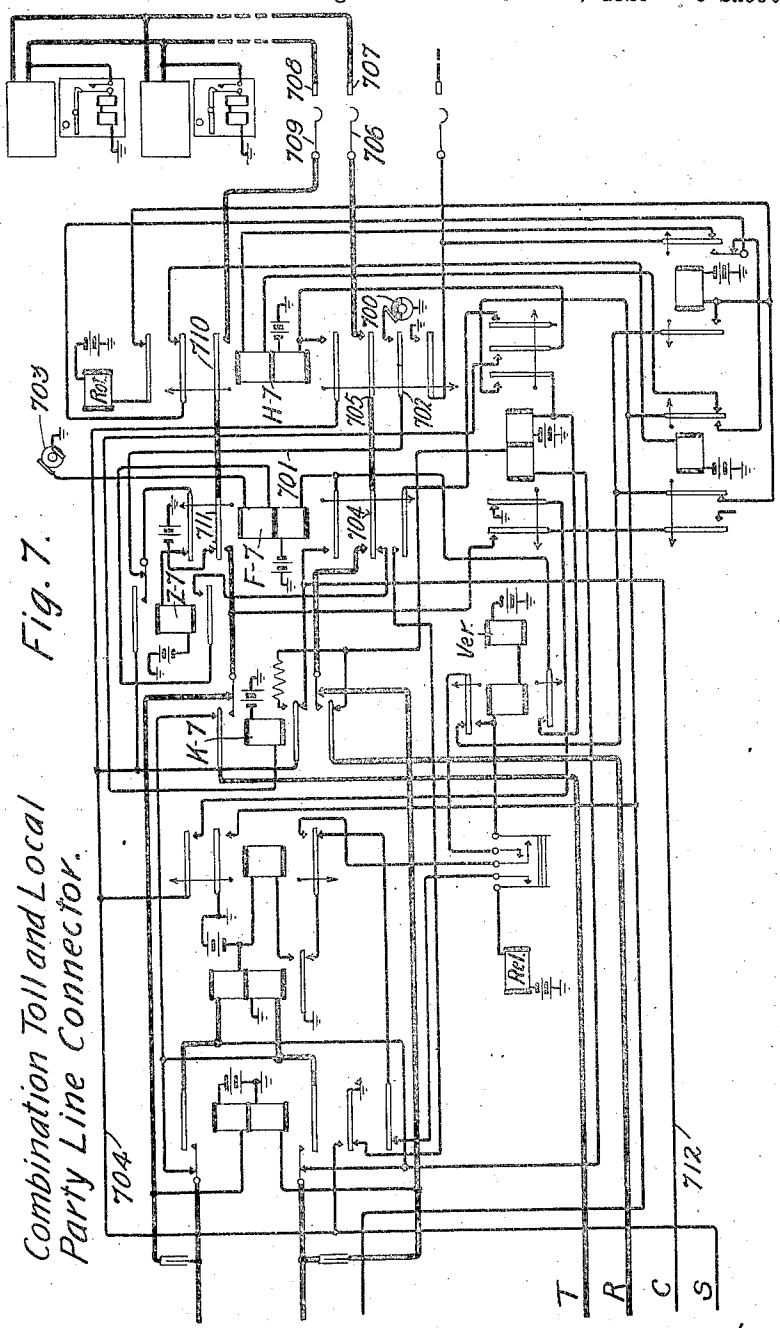

Fig. 7.

Combination Toll and Local Party Line Connector.

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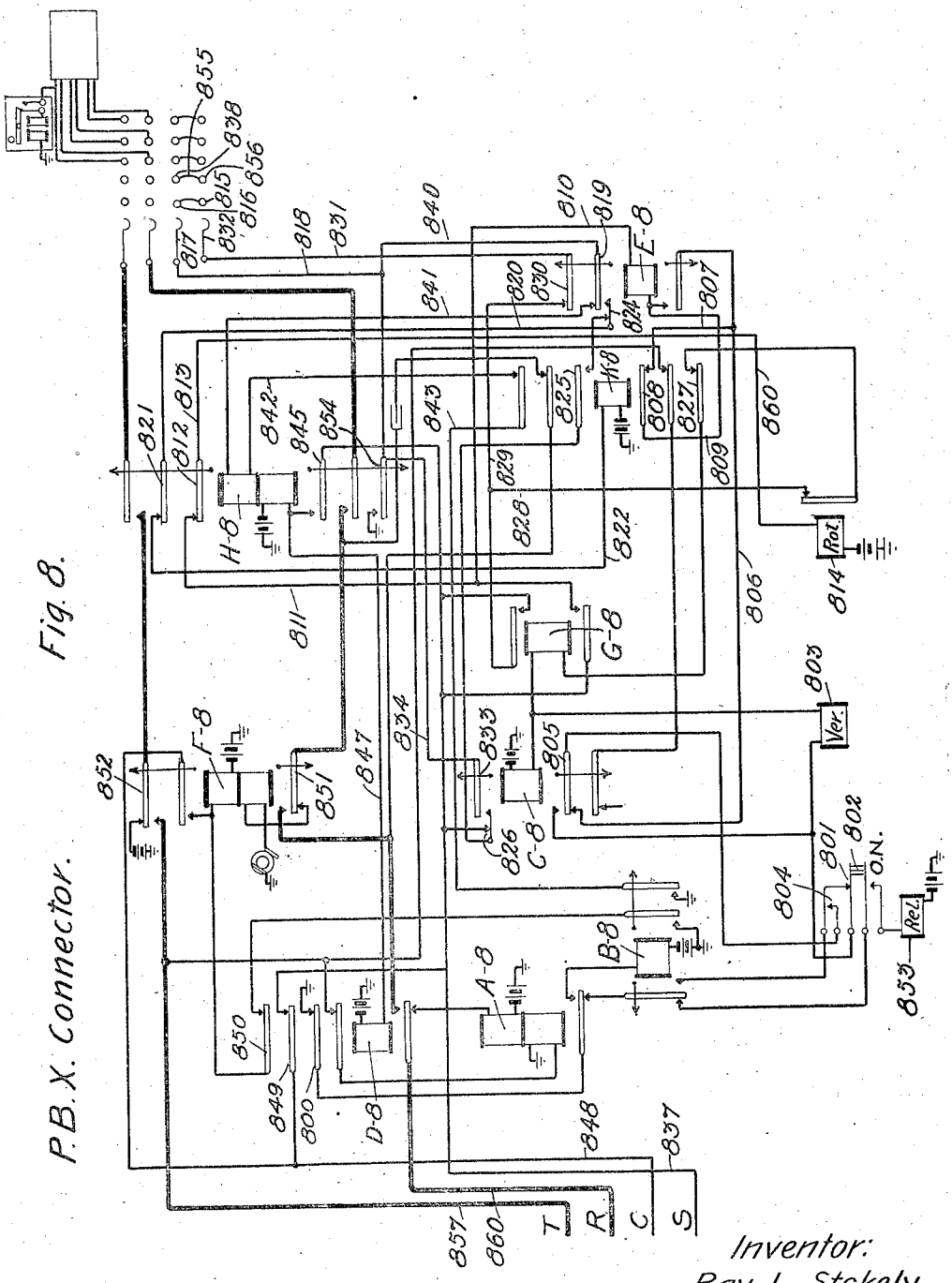

Fig. 8.

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MACHINE SWITCHING TELEPHONE EXCHANGE SYSTEM

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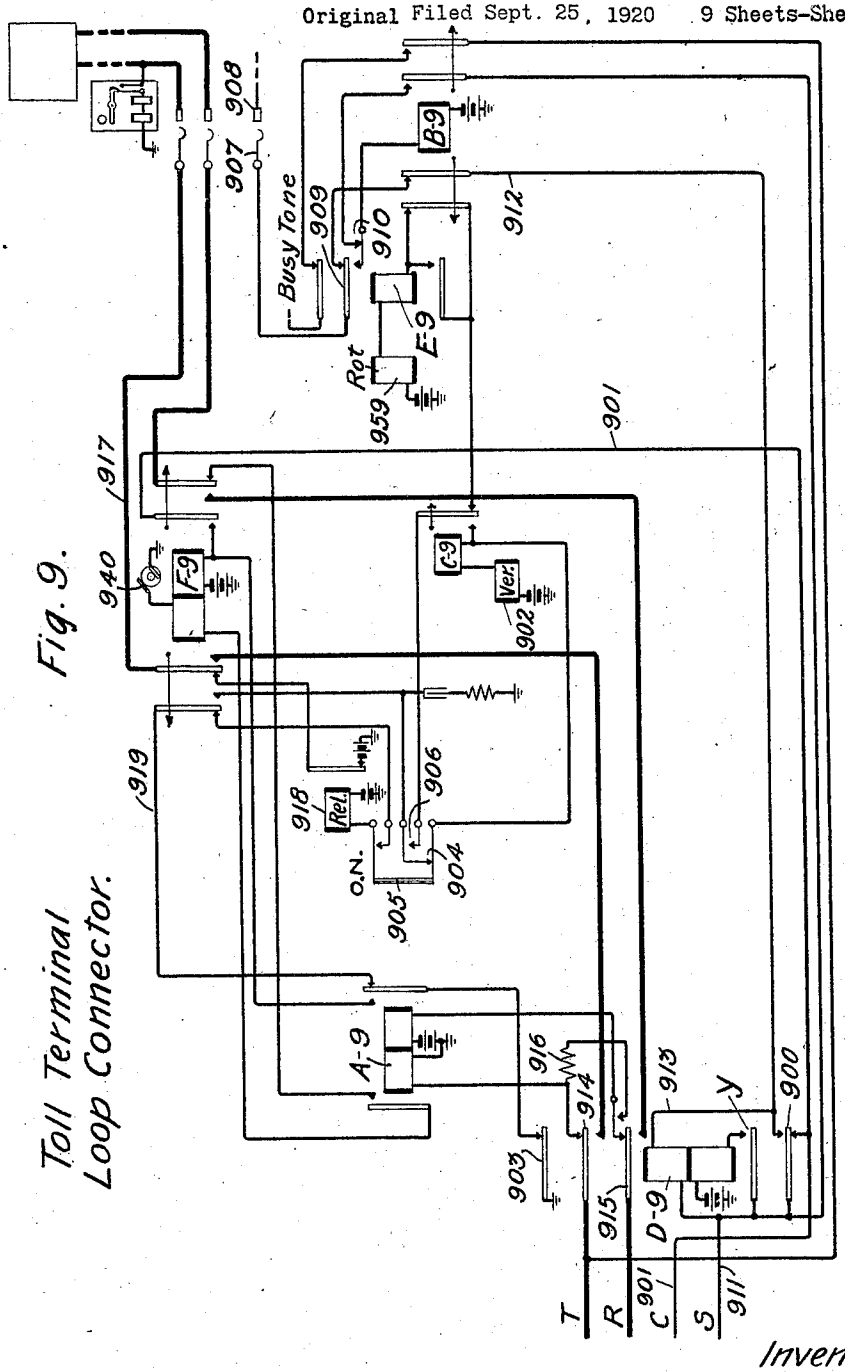

Fig. 9.

Toll Terminal Loop Connector.

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Patented Jan. 11, 1927. 1,613,624

UNITED STATES PATENT OFFICE.

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MACHINE-SWITCHING TELEPHONE-EXCHANGE SYSTEM.

Original application filed September 25, 1920, Serial No. 412,795. Divided and this application filed April 30, 1923. Serial No. 635,793.

This invention relates to telephone exchange systems and more particularly to such systems employing machine switching equipment in the establishment of connections. This application is a division of application, Serial No. 412,795, filed September 25, 1920.

It is broadly an object of this invention to improve conditions and to expedite traffic in systems of the above mentioned character.

This object is obtained in accordance with one feature of this invention by the provision of a circuit arrangement whereby a calling supervisory signal at a toll operator's position is actuated in one manner if a selector fails to find an idle trunk in the selected group in the process of building up a connection, and in another manner if the called line is found busy by a connector.

The invention will be readily understood from the following detail description made with reference to the accompanying drawings in which Fig. 1 shows a toll cord circuit. Fig. 2 shows a trunk circuit outgoing from the toll board to a full mechanical office. Fig. 3 shows a selector circuit. Fig. 3^A shows a fragmentary modification of Fig. 3; Fig. 4 shows the relay and repeating coil equipment associated with the toll transmission selector circuit. Fig. 5 shows the toll transmission selector circuit. Fig. 6 shows a combination toll and local connector circuit. Fig. 7 shows the combination toll and local connector circuit for party line working. Fig. 8 shows a connector circuit for a P. B. X. working. Fig. 9 shows a so-called toll terminal loop connector circuit. Fig. 10 is a diagram of the manner in which the drawings should be placed together in order to read the circuit.

In order to simplify the description and to render the invention readily discernible, a detail description of the handling of a call over the system disclosed will be given.

The toll operator, having been informed of the number of the wanted line and assuming this line to be in a nearby exchange, tests for an idle trunk by touching the tip of her plug TT to the sleeve of the jack TSJ of the toll switching trunk in the well known manner, and if she does not receive a click in her receiver she inserts the plug TT into the toll switching trunk jack TSJ. A circuit is thereupon closed to operate relays E^{99}, (Fig. 1) and B^2 (Fig. 2). Relay E^{99} in operating disconnects the operator's busy test circuit from the tip of the cord. Relay B^2 (Fig. 2) in operating prepares certain circuits which will be traced later. This trunk will now test busy at the other operator's positions due to battery applied to the sleeve multiples by the sleeve of the plug TT. The insertion of the plug also closes the following circuit to energize relay C^2; free pole of battery, resistance 200, right hand winding of relay C^2, conductor 201, armature 202 of relay G^2, conductor 203, ring contacts of jack TSJ and plug TT, conductor 110, lower normal contact of ringing key RK, right hand winding of retardation coil 111, winding of relay B^{43}, armature and back contact of relay E^{155}, which is not operated when the plug TT is inserted in the toll trunk switching jack, but only when it is inserted in a toll line leading to a distant office, left hand winding of retardation coil 111, upper normal contact of ringing key RK, front contact and armature of relay E^{99}, conductor 102, right hand normal make before break contact of relay E^{72}, conductor 103, tip contacts of plug TT and jack TSJ, armature 204 and back contact of relay G^2 and winding of relay A^2 to ground. Relay A^2 is marginal and does not operate in this circuit. Relay C^2 in attracting its armature closes the following circuit to operate relay A^3, which is the impulse relay of the first selector shown in Fig. 3; free pole of battery, lower winding of relay A^3 (Fig. 3), conductor 300, back contact and armature 301 of relay D^3, conductor 302, conductor 205, conductor 206, outer left hand armature and back contact of relay H^2, conductor 207, armature and front contact of relay C^2, left hand winding of relay C^2, conductors 208 and 209, front contact and inner right armature of relay B^2, conductor 210, polarized relay F^2, conductor 211, conductor 212, conductor 303, armature 304 and back contact of relay D^3, conductor 305, upper winding of relay A^3, conductor 306, normally closed contact of switch 307, (which is operated on the eleventh rotary step of the selector), to ground. The operator now throws the dialing and monitoring key DK whereupon an obvious circuit is closed to operate relay B^{34}, Fig. 1, which

in attracting its armature causes the operator's head set to be connected across the cord. She now rotates the dial D for the first digit of the desired number. The closure of the contact 104 of the dial as the dial moves off normal shunts out relay B^{34}, operates marginal relay E^{72} and releases relay B^{34}. Relay E^{72} in attracting its left hand armature locks itself to ground at the contact of the dialing key DK, which when actuated remains in its operated position until manually released by the operator. Relay E^{72} in closing its right hand contact connects the free pole of battery through the impulse contact 108 of the dial to the tip of the plug interposing a break in the tip conductor. The interposition of this break in the tip conductor opens the circuit heretofore traced through the right hand winding of relay C^2. Marginal relay A^2 now operates in series with the impulse contact of the dial, the circuit being as follows: free pole of battery, resistance 109, impulse contact 108, right hand armature and front contact of relay E^{72}, conductor 103, tip contacts of plug TT and jack TSJ, armature 204 and back contact of relay G^2, conductor 213, and winding or relay A^2 to ground. Relay A^2 in attracting its left hand armature bridges relay I^2 across the tip and ring of the cord in parallel with the left hand winding of relay C^2. Relay I^2 in attracting its armature closes a circuit to operate relay D^2 as follows: free pole of battery, resistance 214, conductor 215, winding of relay D^2, conductor 216, right hand armature and front contact of relay I^2, conductor 217, contact 218 of relay G^2 to ground. Relay D^2 in attracting its left armature short circuits the left hand winding of relay C^2 which thereupon releases, thus opening one of the bridges to the impulse relay A^3 and leaving bridged across the circuit only relay I^2. This circuit may be traced as follows: free pole of battery, lower winding of relay A^3, conductor 300, back contact and armature 301 of relay D^3, conductor 302, conductor 205 and 206, outer left hand armature and back contact of relay H^2, conductor 207, conductor 298, relay I^2, and left hand armature of relay A^2, conductor 211, conductor 212, conductor 303, armature 304 and back contact of relay D^3, conductor 305, upper winding of relay A^3 and upper normal contacts 307 to ground. Relay D^2 at its right hand armature and front contact closes the following circuit to operate relay E^2: free pole of battery, winding of relay E^2, conductor 220, right hand armature and front contact of relay D^2, conductor 221, conductor 242 and 228, inner left armature and front contact of relay B^2 to ground. Relay E^2 in attracting its inner right hand armature locks itself to grounded conductor 242. The functions of this relay will be hereinafter described. Dial D, Fig. 1, in returning to normal, interrupts at its impulse contact 108 the circuit of the impulse relay A^2, Fig. 2, which at its left hand armature interrupts the circuit of the impulse relay A^3, Fig. 3, the number of times corresponding to the first digit of the desired number. Upon each retraction of the armature of relay A^3, the following circuit is closed for the vertical magnet 310 of the first selector: grounded armature 311, and back contact of relay D^3, conductor 312, armature and back contact of relay A^3, lower armature and front contact of slow releasing relay B^3, winding of slow relay C^3, vertical magnet 310, and free pole of battery to ground. On the first step of the selector off normal springs 313 close the following circuit for relay 314; free pole of battery winding of relay 314, conductor 315, off normal springs 313, conductors 316 and 317, armature and front contact of relay C^3 to to ground at the armature and front contact of relay B^3. Relay 314 in attracting its upper armature locks itself over the following circuit: free pole of battery, winding of relay 314, conductor 315, off normal contact 313, conductor 316, armature and back contact of rotary magnet 318, conductor 319, conductor 320, upper armature and front contact of relay 314, conductor 321 to ground at the armature 311 and back contact of relay D^3. Upon the cessation of the impulses, however, relay A^3 remains energized and consequently relay C^3, which is slow to release, after an interval, releases whereupon the following circuit is closed to energize the rotary magnet 318 of the selector to step the selector brushes on to the first trunk in the selected level: free pole of battery, magnet 318, conductor 322, front contact and lower armature of relay 314, upper normal contact of relay C^3, front contact and upper armature of relay B^3 to ground. At the end of its stroke, the rotary magnet 318 opens the locking circuit traced for relay 314. Relay 314 in retracting its lower armature opens the circuit of the rotary magnet 318. If the first trunk is busy, ground is present on the test multiple 323 thereof, whereby the following circuit is closed to energize relay 314: grounded multiple 323, test brush 324, conductor 325, armature 326 and back contact of relay D^3, conductors 327 and 319, back contact and armature of magnet 318, conductors 316, contact 313, conductor 315, relay 314 to free pole of battery and ground. Relay 314 in attracting its upper armature again locks itself through the back contact of the rotary magnet 318 and in attracting its lower armature again closes the circuit of the rotary magnet whereupon the selector brushes are stepped to the next trunk. This action of

the relay 314 and rotary magnet is continued until an idle trunk is found which is indicated by the absence of ground on the test multiple 323 thereof. When the rotary magnet at the end of its stroke positions the brushes on to an idle trunk and no ground is present, relay 314 does not energize but relay D^3 energizes over the following circuit: ground free pole of battery, winding of relay 314, conductor 315, contact 313, conductor 316, armature and back contact of rotary magnet 318, conductor 319, conductor 327, conductor 328, winding of relay D^3, conductor 329, lower normal contact of switch 307, conductor 330, to ground at the upper armature and front contact of relay B^3. Relay 314 is marginal and does not operate in this circuit. Relay D^3 in attracting its armatures 304 and 301 extends the talking conductors through to the selector brushes and cuts off impulse relay A^3.

Assuming now that the selector has failed to find an idle trunk. In that event on the eleventh rotary step, switch 307 operates and opens at its uppermost contacts the circuit of the impluse relay A^3 which causes the selector (Fig. 3) to restore. The opening of this loop circuit also causes relay I^2 to be permanently deenergized. Relay A^2 in remaining energized and relay I^2 being inert, the following short circuit is closed about slow relay D^2 to cause the same to release: ground, free pole of battery, resistance 214, right hand armature and front contact of relay A^2, armature and back contact of relay I^2, conductor 217, contact 218, to ground. It will be understood that relay D^2 is slow to release as shown, and holds up between the impulses of one digit. Relay D^2 in retracting its right armature operates relay H^2 over the following circuit: ground, free pole of battery, winding of relay H^2, conductor 222, right hand armature and back contact of relay D^2, conductor 220, inner right hand armature and front contact of relay E^2 to ground on conductor 242. Relay H^2 in attracting its inner left hand armature locks itself up to grounded conductor 242 and in attracting its inner right armature connects interrupter 223 to the inner left hand armature and front contact of relay E^2 to shunt the resistance 200 and cause supervisory relay B^{43} in the cord circuit to flash the trunk and toll supervisory lamp 100 at the rate of 60 flashes per minute when the operator restores the key DK. This rate of flashing will indicate to the operator that one of the switches has encountered a busy trunk group whereupon she will pull out plug TT and will then wait and set up the connection later, or insert the plug into another jack and again set up the connection by way of another trunk. While the interrupting machine 223 is connected to the front contact of relay H^2, as soon as relay D^2 releases, this operation is not effective to flash the lamp until the operator, after having turned the dial for the last time, releases her dialing key DK, Fig. 1. The opening of the lowermost contact of this key releases relay E^{72} which in retracting its right armature again closes the loop circuit including the right hand winding of relay C^2, Fig. 2, and the windings of relay A^2, Fig. 2 and B^{43} (Fig. 1). It will, of course, be understood, if no idle trunk is found relay G^2 is not energized. Relay H^2 in attracting its outer left hand armature interposes a break in the loop circuit leading to the selector (Fig. 3) thus preventing the subsequent sets of impulses from operating the switches.

The seizure of the toll transmission selector, Fig. 5, with which the relay and repeating coil equipment of Fig. 4 is associated, causes the closure of the following circuit for impulse relay A^5, Fig. 5 of the toll transmission selector: ground, free pole or battery, right hand winding of relay A^5, conductor 500, conductor 400, conductor 401, back contact and outer left armature of relay B^4, conductor 402, contact 403 of relay F^4, conductors 404 and 405, upper left hand winding of repeating coil 406, conductor 407, multiple terminal 351, brush 350, conductor 352, front contact and armature 304 of relay D^3, conductors 303, 212 and 211, left hand armature and front contact of relay A^2, winding of relay I^2, conductors 298, 207, back contact and outer left hand armature of relay H^2, conductors 206, 205 and 302, armature 301 and front contact of relay D^3, conductor 332, brush 333, multiple terminal 334, conductor 408, lower left hand winding of repeating coil 406, conductor 409, contact 410 of relay F^4, conductor 411, contact 412 of relay B^4, conductor 413, conductor 501, through the left hand winding of relay A^5 to ground at the lower normal contact of the switch 502 which is operated on the eleventh rotary step of the transmission selector. The impulse relay A^5 in attracting its right hand armature energizes slow relay B^5. This relay in attracting its left armature closes a circuit for relay 336 (Fig. 3) which in attracting its armatures applies a local ground to the test multiple 323 to cause this trunk to test busy. Relay 336 is provided when the transmission selector is not located in the same office as the selector circuit of Fig. 3, to take care of differences in ground potentials and trunk resistances. If the toll selector is in the same office, ground from the outer left armature and front contact of relay B^5 is transmitted to the test multiple 323, and relay 336 is omitted, as indicated in the drawing Fig. 3^A. When the relay B^5 operates it closes, at its right

hand armature, the following circuit for relay D^4 in the relay and repeating coil circuit, Fig. 4: ground, right armature and front contact of relay B^5, conductors 503 and 518, conductor 504, conductor 505, contact 506 of relay D^5, conductor 507 and 414, outer right hand armature and back contact of relay F^4, conductor 415, winding of relay D^4, free pole of battery to ground.

The second operation of the dial by the operator transmits the second digit of the called line causing relay A^2, Fig. 2 to open and close the loop circuit for relay A^5, which, in vibrating its right hand armature, transmits impulses over the following circuit to the vertical magnet 508 of the toll transmission selector: ground, right hand armature and back contact of relay A^5, inner armature and front contact of relay B^5, conductor 509, armature 510 and back contact of relay D^5, conductor 511, slow relay C^5 magnet 508 to free pole of battery and ground. The brushes of the toll transmission selector are thus elevated to the desired level. When the dial returns to normal and maintains the relay A^2 energized, relay A^5 remains energized and, after a slight interval, slow relay C^5 releases. When the relay C^5 operated on the first impulse and the selector took its first step, relay E^5 corresponding to relay 314 (Fig. 3) operated over the following circuit: ground, free pole of battery, winding of relay E^5, upper contact of off normal switch 515, conductor 516, armature and front contact of relay C^5, conductor 517, conductor 518, conductor 503 to ground at the right armature and front contact of relay B^5. In attracting its inner armature, relay E^5 locks itself to the upper armature and back contact of slow relay F^5, this circuit including the armature and back contact of rotary magnet 519. These circuits are similar to those of the selector of Fig. 3. Upon the cessation of the impulses and the release of slow relay C^5, the circuit of the rotary magnet is closed as follows: free pole of battery, magnet 519, outer armature and front contact of relay E^5, normal contact of relay C^5, conductor 517, conductor 518, conductor 503, right armature and front contact of slow relay B^5 to ground. The rotary magnet advances the brushes on to the terminals of the first trunk and at the end of its stroke opens the locking circuit of the relay E^5 which releases, opening the circuit of the rotary magnet. If the trunk is busy, relay E^5 again energizes over the following circuit: ground, free pole of battery relay E^5, upper contact of switch 515, conductor 516, conductor 520, back contact and armature of rotary magnet 519, conductor 521, conductor 522, back contact and armature 523 of relay D^5, conductor 524, lowermost armature and back contact of relay F^5, conductor 525, test brush 526 to ground on the test multiple 527. Relay E^5, in attaching its inner armature again locks up through the upper armature and back contact of relay F^5 and at the other armature again closes the circuit of the rotary magnet which advances the brushes to the next trunk and at the end of its stroke opens the locking circuit of relay E^5 which in retracting its armature opens the circuit of the rotary magnet 519. The switch 502 of the toll transmission selector, Fig. 5, corresponds to the switch 307 of the selector circuit, Fig. 3. Its function is to open the circuit of the impulse relay A^5 on the eleventh rotary step of the toll transmission selector, that is to say, if all the trunks in the group are busy. The opening of this circuit releases the switch and causes relay I^2 Fig. 2 to become permanently inert which causes the release of slow relay D^2 and prepares a circuit for the interrupter 223 which results in the flashing of the trunk and toll supervisory lamp 100 when the operator restores her dialing key as described in detail in connection with Fig. 3. If, however, an idle trunk is found, relay D^5, which corresponds to relay D^3 Fig. 3, operates over the following circuit: ground, free pole of battery, relay E^5, upper contact of switch 515, conductor 516, conductor 520, back contact and armature of magnet 519, conductors 521 and 522, winding of relay D^5, upper normal contact of switch 502, conductors 530 and 503 to ground at the right hand armature and front contact of relay 502. Relay E^5 is marginal and does not operate in this circuit in series with the relay D^5. Relay D^5 then operates and in attracting its armatures 531 and 532 extends the talking conductors through to the talking brushes 533 and 534. The attraction of the armature 523 of relay D^5 grounds the test brush 526 and consequently test multiple 527 of the selected trunk causing the same to test busy to other selectors. The contact 535 is made before the contact 506 is broken by the armature 537 of the relay D^5. Consequently relay D^4 Fig. 4 in the relay and repeating coil equipment is maintained energized over the following circuit: ground, free pole of battery, winding of relay D^4, conductor 415, back contact and outer right hand armature of relay F^4, conductor 414, conductor 507, contact 535, conductor 538, brush 539, multiple 540, control conductor 541, conductor 600, conductor 601, back contact and armature 602 of relay K^6, conductor 603, sleeve conductor 650, conductor 542, multiple 527, brush 526, conductor 525, back contact and lowermost armature of relay F^5, conductor 524, armature 523 and front contact of relay D^5, conductor 518, conductor 503, to ground at the right hand armature and front contact of slow relay B^5. Thus, the circuit for relay

D^4 (Fig. 4) is maintained closed as the circuit is extended from switch to switch. As will hereafter appear, relay F^4 is not operated until the desired line is found idle and seized, when it reverses the direction of current flow in the circuit leading back to the toll operator's position to light the supervisory lamp 100 to indicate to her the idle condition of the line, whereupon she will cause the connector to begin the automatic ringing operation. The switch of Fig. 6 to which the connection has been extended is a combination toll and local connector containing multiples of ordinary lines and its bank. This switch is accessible not only to the toll transmission selectors of Fig. 5 but also to the local selectors which are used by the subscribers in building up their own local connections. The seizure of the connector causes the closing of the following circuit for the impulse relay A^6: ground, free pole of battery, upper winding of relay A^6, conductor 604, conductor 605, left winding of slow relay J^6, conductors 606 and 607, back contact and lowermost armature of relay K^6, ring conductor 646, conductor 543, multiple 544, brush 534, conductor 545, front contact and armature 532 and front contact of relay D^5, left hand armature and front contact of relay A^5, ring conductor 546, conductor 416, inner lower armature and back contact of relay K^4, conductor 419, lowermost armature and back contact of relay H^4, conductor 421, lower right hand winding of the repeating coil 406, resistance 460, conductor 422, left hand armature and front contact of relay D^4, resistance 423, conductor 424, resistance 461, upper right hand winding of repeating coil 406, back contact and upper armature of relay H^4, conductor 425, back contact and uppermost armature of relay K^4, tip conductor 426, conductor 547, armature 531 and front contact of relay D^5, conductor 548, brush 533, multiple 549, tip conductor 550, conductor 610, upper armature and back contact of relay K^6, conductor 611, conductor 612, lower winding of relay A^6 to ground. Relays J^6 and A^6 operate in this circuit, the former at its innermost right armature closing a locking circuit for itself as follows: ground, free pole of battery, right hand winding and right innermost armature and front contact of relay J^6, conductors 614, 631 and 615 to ground at the armature 616, and front contact of slow relay B^6 which is energized upon the energization of the impulse relay A^6. Relay B^6 grounds the sleeve wire 617, leading to the test multiples in the local selectors, this circuit leading from grounded armature 616, conductor 615, to conductor 617. The return of the dial to normal after the operation of transmitting the tens digit of the desired number interrupts the circuit of relay A^2, Fig. 2 which in turn interrupts the circuit of the impulse relay A^5, Fig. 5 which, in vibrating its armatures, causes the impulse relay A^6 of the connector to transmit impulses to the vertical magnet 618 of the connector over the following circuit: ground, free pole of battery, winding of magnet 618, winding of slow relay 619, right contact of off normal switch 620, conductor 621, front contact and lower armature of relay B^6 to ground at the armature and back contact of the impulse relay A^6. At the first step of the connector, the off normal springs 620 are shifted and the succeeding impulses are transmitted by way of the upper armature and front contact of relay 619 and the contact 622 now closed at the off normal springs 620. The selector brushes are thus lifted to the desired level and upon the cessation of the impulses, impulse relay A^6 remains energized and relay 619 in series with the vertical magnet 618 releases, preparing the circuit of the rotary magnet 623. The units impulses pass through the back contact of the impulse relay A^6, lower armature and front contact of relay B^6, conductor 621, off normal contact 622, upper armature and back contact of slow relay 619, conductor 624, inner left hand armature and back contact of relay G^6, conductor 625, back contact and uppermost armature of relay H^6, winding of rotary magnet 623, free pole of battery to ground. The connector is thus stepped around into engagement with the desired line.

If this line is idle, potential is present on its test multiple 626 through the cut off winding of the line switch and, the following circuit is closed to operate relay H^6: multiple 626, brush 627, conductor 628, right hand armature and back contact of relay E^6, conductor 629, upper winding of relay H^6, conductor 630, back contact and right hand armature of relay G^6, conductors 631 and 615, armature 616 of relay B^6 to ground. Relay H^6 in attracting its armature 632 locks itself to the grounded sleeve wire 650 and extends this grounded conductor over conductor 633, middle right armature and front contact of relay J^6, conductor 634 to the winding of relay K^6. Relay K^6 in attracting its armature 602 disconnects the grounded sleeve wire 650 from the control lead 600 leading back to the relay D^4, Fig. 4 of the relay and repeating coil equipment circuit. Relay D^4 in retracting its outer right hand armature operates relay F^4, Fig. 4, over the following circuit: ground, free pole of battery, winding of relay F^4, conductor 428, back contact and outer right hand armature of relay D^4, conductor 429, conductor 550, armature 523 and front contact of relay D^5, conductor 518 to ground at the right hand armature and front contact of relay B^5. Relay F^4 in attracting its outer right hand armature closes a sub-

stitute ground to hold up the relay F^6 to prevent ringing from occurring at this time: ground, right hand armature and back contact of relay E^4, conductor 430, back contact and right hand armature of relay B^4, outer right armature front contact and outer right hand armature of relay F^4, control conductors 414 and 507, contact 535 and uppermost armature of relay D^5, conductor 538, brush 539, multiple 540, conductor 541, conductor 600, front contact, armature 635 and lower winding of relay F^6 to free pole of battery and ground. Relay F^6 was energized upon the first impulse to the vertical magnet, this circuit being as follows: ground, free pole of battery, lower winding of relay F^6, lower armature and front contact of slow relay 619, innermost right hand armature and front contact of relay J^6, conductor 614, conductors 631 and 615 to ground at the upper inner armature and front contact of relay B^6. When energized, relay F^6 locks by way of its armature 635 and front contact, conductor 601, back contact and armature 602 of relay K^6 to grounded sleeve wire 650. Consequently, the operation of relay K^6 to cause the reversal of direction of the current flow in the loop leading back to the toll operator's position would deenergize relay F^6 and unless a substitute circuit is provided for holding up relay F^6 the ringing operation would automatically take place. This is prevented by applying ground to the control conductor 600 over the circuit traced to hold the relay F^6 until the operator, by depressing a key as will be explained, releases relay F^6 to start the automatic ringing operation. The release of the relay D^4 and the consequent energization of relay F^4 as described reverses the direction of current flow in the talking conductors leading back to the operator's position. After having turned the dial for the last time, the operator restores her dialing key DK which releases relay E^{72} which in turn disconnects the dial from the tip of the plug causing the release of the relay A^2 Fig. 2 and causes the closure of an energizing circuit for the right hand winding of relay C^2, relay B^{43} and relay A^2. Relay A^2 it will be remembered, releases under this condition and in retracting its left armature deenergizes relay I^2, which in releasing causes the release of relay D^2. The polarized relay F^2 is now bridged across the following circuit: upper talking conductor 212 Fig. 2, conductor 211, windings of polarized relay F^2, conductor 210, inner right hand armature and front contact of relay B^2, conductor 209, conductor 208, left hand winding of relay C^2, front contact and armature of relay C^2, conductor 207, outer left hand armature and back contact of relay H^2, conductor 206 to lower talking conductor 205. The reversal of the direction of current in these talking conductors due to the operation of relay F^4 causes the relay F^2 to cooperate, closing the following circuit for relay G^2 ground: free pole of battery, winding of relay G^2, conductor 224, contact 225 and armature of relay F^2, conductors 226, 227, 228, inner left hand armature and front contact of relay B^2 to ground. Relay G^2 locks itself up over the following circuit: ground, free pole of battery winding of relay G^2, conductor 224, conductor 229, front contact and armature 230 of relay G^2, conductors 231, 227 and 228 to ground at the inner left hand armature of relay B^2. Relay G^2 connects the talking conductors of Fig. 2 through to the talking conductors of Fig. 1 whereupon the trunk and toll relay B^{43} operates in series with the relay A^5 (Fig. 5) and lights the supervisory lamp 100 as a ringing signal to the toll operator. Relay G^2 (Fig. 2) cuts off the bridge including relays C^2 and A^2. The operator now operates her ringing key RK which impresses alternating current upon the talking conductors and operates the alternating current relay C^4 which in attracting its armature operates the relay E^4 in an obvious circuit. This relay in attracting its right armature opens the circuit heretofore traced, which has been holding relay F^6, (Fig. 6) energized. This relay in retracting its armature 637 connects ringing current to the called line through the upper winding of relay F^6. This ringing current is automatically continued until the called party removes his receiver, resulting in the increase in the current through the upper winding of relay F^6 causing the same to operate removing the ringing current. The attraction of the armature 635 of this relay closes a locking circuit for the same over control conductor 600. The extension of the tip and ring conductors by relay F^6 to the called line operates relay A^4 over the winding of which talking current is fed to the called line. Relay A^4 in operating energizes relay B^4 which in attracting its right hand armature applies ground to the conductor 414 to hold up relay F^6, (Fig. 6) independently of the relay E^4. Relay B^4 in attracting its left hand armature opens the connection of battery through the windings of relay A^5, (Fig. 5) to the talking conductors 407, 408, leading back to the operator's position which causes the deenergization of supervisory relay B^{43}. This relay in retracting its armature extinguishes the supervisory lamp 100 which notifies the operator that the subscriber has responded. Talking current is fed to the called line over the winding of relay A^4 and the repeating coil 406. This talking circuit is a standard repeating coil transmission circuit used in long distance connections. Talking current

is fed to the calling line from the calling distant exchange. During conversation the trunk leading from the left hand windings of repeating coil 406 through the right hand winding of the repeating coil (not shown) at the distant office is dry, in accordance with standard practice.

Assuming now that the desired line when selected by the connector is busy. In that condition the test multiple 626 Fig. 6 is grounded. When test wiper 627 is set on the busy multiple 626, ground is extended over brush 627, conductor 628 right hand armature and contact 640 of relay E^6, conductor 641, armature 642 and back contact of relay H^6, conductor 643 winding of relay G^6, free pole of battery to ground. Relay G^6 energizes and when relay E^6 releases locks itself up over the following circuit: ground, free pole of battery, relay G^6, conductor 643, back contact and armature 642 of relay H^6, conductor 641, make before break contact of relay E^6, front contact and right hand armature of relay G^6, conductor 631, conductor 615 to ground at the armature 616 and front contact of relay B^6. Relay G^6 in the case of a local call connects busy tone from the source 645 to the calling line. In the case of a toll call this busy tone is not used, a flashing signal being given to the operator instead. By reason of the ground connection to the multiple 626 of the selected line relay H^6 does not operate. Consequently, relay K^6 is not energized to open the circuit of relay D^4 (Fig. 4) as described in the case of an idle line. Inasmuch as relay D^4 remains energized, relay F^4, whose circuit is maintained open at the outer right hand armature and back contact of relay D^4 is not operated and no current reversal in the trunk leading back to the operator's position occurs. Polarized relay F^2 (Fig. 2), is not operated in this case and relay G^2 remains inert. Since the relay E^2 is locked up at this time and relay G^2 is inert, when the operator restores her dialing key DK the following circuit is closed from interrupter 233 of 120 impulses per minute to shunt out resistance 200 to cause the supervisory relay B^{43} to flash the lamp 100, 120 times per minute, which indicates to the operator that the selected line is busy, whereupon she pulls out the plug TT from the trunk switching jack TSJ which results in the release of all switches and the normal condition of all the apparatus including the various locked up relays. During existence of a connection in order to recall the operator the called subscriber by moving his receiver hook up and down causes the supervisory lamp 100 at the toll operator's position to flash as in manual practice without releasing the switches. This is apparent from the preceding description inasmuch as relay A^4 is in circuit with the called line and each time it attracts its armature, operates the relay B^4 which removes battery and ground from the trunk conductors leading back to the supervisory relay B^{43} and puts a bridge across the relay A^5 to hold it operated as long as the subscriber has his receiver off the hook. When the called subscriber replaces his receiver he lights the lamp 100 at the toll operator's position Fig. 1. The operator may rering the subscriber if necessary, if she desires to recall, by actuating her ringing key RK, which in operating actuates relay C^4 to operate relay E^4, which in attracting its right hand armature again releases relay F^6 which initiates the automatic ringing operation. The control of this relay F^6 was removed from the relay E^4 by the attraction of the right armature of relay B^4 when the called subscriber responded and was restored to the relay E^4 and consequently to the operator when the called subscriber replaced the receiver and deenergized relay B^4. When the operator desires to break down the connection after the called subscriber has replaced his receiver, she removes the plug TT from the toll switching jack TSJ. This releases relay A^5 Fig. 5 which causes the restoration of all the switches. If, however, the operator pulls out the plug while the called subscriber still has his receiver off the switchhook, the switches are not released since relay A^5 which controls the release is maintained energized over the following circuit: grounded battery, right hand winding of relay A^5, conductor 500, conductors 400 and 401, resistance 435, inner left hand armature and front contact of relay B^4, conductors 413 and 501, left winding of relay A^5 to ground at the lower normal contact of contacts 502, it being noted that relay B^4 which controls this loop circuit is itself controlled by relay A^4 in circuit with the called line and controlled at the switchhook of said line.

Assuming, however, that the called subscriber has replaced his receiver, when the operator removes the plug, relay A^5 in releasing deenergizes relay B^5. Relay B^5 in retracting its outer left hand armature removes ground from the sleeve conductor 551 leading over the sleeve conductor 436 to relay 336 which in releasing its armature removes ground from the sleeve wire 325. The removal of this ground releases relay D^3 whereupon the release magnet 340 operates as follows: ground, free pole of battery, winding of magnet 340, off normal switch contact 341, lower armatures and back contacts of relays B^3 and A^3 to ground at armature 311 and back contact of relay D^3. Thus the first selector is restored and upon reaching its normal position opens the off normal springs 313 and 341. The

removal of ground from conductor 503, by the retraction of right hand armature of relay B^5 releases relay D^5 and the retraction of the right hand armature of relay A^5 and inner left hand armature of relay B^5 closes a circuit of the release magnet 552 at the toll transmission selector as follows: ground, free pole of battery, magnet 552, lower contact of off normal switch 515, conductor 553, back contact and inner left hand armature of relay B^5 to ground at the right hand armature and back contact of relay A^5. The slow relay F^5 is energized in parallel with the release magnet and opens the circuit for the test brush 526 during restoration at its lowermost armature. At its armature 554, relay F^5 short circuits the left hand winding of relay A^5. At its upper armature it closes a locking circuit for itself which is opened when the off normal switch assumes its normal position. The opening of the circuit of the tip and ring conductors 610 and 646 causes the release of relays A^6, B^6, J^6, (Fig. 6) which results in the closure of the circuit of release magnet 686: free pole of battery, magnet 686, left hand contact of off normal switch 620, back contact and lowermost armature of relay D^6, lower armatures and back contacts of relays B^6 and A^6 to ground. The connector upon reaching normal position restores the off normal switch 620.

Referring now to Fig. 7, this represents a combination toll and local connector for party line working. The arrangement for party line working shown employs what is known as segregated grouping, each connector having a generator of a certain character associated with it and only the stations on the line having bells responsive to this generator appear in the multiple bank of this connector, in accordance with the well known practice. The only difference between the circuits of Fig. 6 and Fig. 7 is that a so-called pick-up relay Z^7 is provided to insure that the ringing will commence at the beginning of the code. It will be remembered that if the line is idle relay H^7 operates, and in operating operates relay K^7 which causes the reversal of the current flow in the circuit leading back to the toll operator's position to light the lamp 100 as a ringing signal to her. She thereupon presses the ringing key whereupon relay C^4 (Fig. 4) operates to energize relay E^4 (Fig. 4) which in operating causes the release of relay F^7. However, when this circuit releases relay F^7 does not alone impress ringing current on the called line but instead prepares a circuit for a pick-up relay Z^7 as follows: ground, free pole of battery, winding of relay Z^7, uppermost armature and back contact of relay F^7, normal contact of relay Z^7, conductor 701, armature 702 and front contact of relay H^7, interrupter 700 to ground if the interrupter brushes are on the metallic segment. Thus relay Z^7 can only be operated before the beginning of the code ringing transmitted by the ringing machine, and locks itself over its upper armature to the grounded sleeve wire 714. In attracting its lower armature relay Z^7 prepares the ringing circuit and upon the ringing machine reaching its ringing position code ringing current is impressed on the called line over the following circuit: ringing machine 703, upper winding of relay F^7, lower armature and front contact of relay Z^7, armature 704 and back contact of relay F^7, armature 705, brush 706, multiple 707, through the bell at the called station, returning over the upper talking conductor, multiple 708, brush 709, front contact and armature 710 of relay H^7, armature 711, and back contact of relay F^7 to grounded battery pole of the generator. This code ringing continues until the called party answers, whereupon the ringing cutoff relay F^7 operates connecting the calling and called ends of the talking conductors together and locking itself to the control conductor 712. From this point the operations are the same as those described in connection with Fig. 6.

Referring now to Fig. 9. This figure represents a toll connector circuit, that is to say connectors which are accessible only to the toll transmission selectors of Fig. 5 and not to local selectors. These switches are provided where certain lines have an unusually large amount of toll traffic. When the toll transmission selector of Fig. 5 seizes a connector of Fig. 9, the ground on sleeve conductor 542 is transmitted over conductor 911, armature 900 and back contact of relay D^9 to the control conductor 901, conductor 541, armature 537 and front contact of relay D^5, control conductor 507 to hold the relay D^4 (Fig. 4) energized. When the toll connector is selected by the toll transmission selector, relay A^9 is energized over the loop leading back to the circuit of Fig. 4 as described, and the interruption of this loop due to the operation of the dial causes relay A^9 to transmit impulses over the following circuit to the vertical magnet 902 of the connector: ground, armature 903 and back contact of relay D^9, right hand armature and back contact of relay A^9, conductor 919, outer left hand armature and front contact of relay F^9, contact 904 of off normal switch 905, winding of slow relay C^9, winding of vertical magnet 902, free pole of battery to ground. Relay F^9 energizes over its right hand winding and the right hand armature of relay A^9 when relay A^9 becomes energized. Relay F^9 locks to lead 901. The vertical magnet 902 responding to these impulses at the first step opens

off normal switch 905, but relay C^9 remains operated over contact 906 at its armature and front contact. Relay C^9 is slow to release and holds itself energized between the impulses, but restores at the end of the first series of impulses and shifts the impulse circuit to the rotary magnet. The impulses corresponding to the units digit now pass over the back contact of the relay C^9. Relay E^9 in the rotary stepping circuit, being slow to release, holds up between the impulses and the second and succeeding impulses pass through the rotary magnet 959, over the lower armature and front contact of relay E^9. Relay E^9 in operating connects relay B^9 to the test brush 907. If the line is idle however, relay B^9 is not operated, since there is no ground on the multiple 908 thereof, but full potential through the cut-off winding of the called line switch. This current is transmitted over the armature 909 and back contact of relay E^9, inner left hand armature and back contact of relay B^9, conductor 912, conductor 913, upper winding of relay D^9 to the grounded sleeve wire 911. Relay D^9 gets sufficient current through the bridge cut-off winding to operate sufficiently to make its contact Y when its lower winding is brought into circuit which permits it to energize sufficiently to attract all its armatures. In attracting its armatures it disconnects the grounded sleeve conductor 911 from the control conductor 901 to deenergize relay D^4 (Fig. 4) which causes the current to be reversed in the trunk leading back to the toll operator's position to cause the lamp 100 to be lighted as a ringing signal as described heretofore in detail. In attracting armatures 914 and 915 it connects the incoming and outgoing tip and ring conductors together and disconnects relay A^9; the armature 915, however, closes a circuit through resistance 916 to hold the relay A^9 energized. While the attraction of armature 900 of relay D^9 removed ground from the holding winding of relay F^9, ground is returned over the control conductor 901 to the holding winding to hold the same energized and prevent ringing until the operator depresses her ringing key. When she presses her ringing key she operates relay C^4 (Fig. 4) which in turn operates relay E^4 (Fig. 4) to remove this ground from the control lead. Relay F^9 thereupon releases and transfers the called line from the trunk to the machine ringing circuit. The ringing circuit is as follows: ground at generator 940, left hand winding of relay F^9, left hand armature and front contact of relay A^9, outer right hand armature and back contact of relay F^9, lower talking conductor, through the substation, upper talking conductor, inner left hand armature and back contact of relay F^9 to grounded battery at the armature and back contact of release magnet 918. When the called party removes his receiver in response to this signal, relay F^9 operates and again locks itself to the control conductor 901 which is now grounded at the right hand armature and back contact of relay E^4, (Fig. 4). In operating it cuts off the ringing current and again extends the called line to the toll trunk. Battery current is fed to the called line over relay A^4 and the repeating coil 406 as in Figs. 4 to 6 and the called subscriber controls supervisory lamp 100 at the switch hook contacts.

When the connection is broken down relays D^9 and F^9 release. Relay D^9 releases relay A^9 and the circuit of the release magnet 918 is closed as follows: ground, free pole of battery, magnet 918, upper make contacts of off normal switch 905, outer left hand armature and back contact of relay F^9, conductor 919, back contact and right armature of relay A^9 to ground at the armature 903 of relay D^9. When the switch reaches its normal position the off normal switch 905 is restored to normal.

If the selected line is busy slow relay B^9 is operated from ground at the multiple 908, test brush 907, armature 909 and front contact of relay E^9, winding of slow relay B^9 to free pole of battery and ground. Relay B^9 then locks itself over make before break contact 910 at its inner right hand armature and front contact to the grounded sleeve wire 911. Thus no circuit is closed through the winding of the relay D^9 to operate the same to release relay D^4 (Fig. 4) to reverse the direction of current flow in the circuit leading back to the operator's position. Consequently relay G^2 (Fig. 2) is not operated and the interrupter 233 is connected in shunt of the resistance 200 to intermittently operate relay B^{43} in the operator's cord circuit when she restores her dialing key DK. Thus, the supervisory lamp is flashed to indicate that the line is busy as particularly described in connection with Fig. 6.

Referring now to Fig. 8, this figure shows a toll rotary connector, that is to say a switch which is only reached from the toll transmission selectors and in which each subscriber may have a number of lines running to his station. When this connection is seized by the toll transmission selector, impulse relay A^8 operates over the loop and operates slow relay B^8. Tens impulses pass from ground at the armature 800 and back contact of relay B^8, armature and back contact of impulse relay A^8, left hand armature and front contact of relay B^8, contact 801 of off normal switch 802, winding of magnet 803, winding of slow relay C^8 to free pole of battery and ground. Thus, the connector is lifted to the desired level. Upon the termination of the tens impulses, the

relay C^s releases. The units impulses pass from ground at the armature 800 and back contact of relay D^s, armature and back contact of relay A^s left hand armature and front contact of relay B^s, contact 804 of the off normal switch 802, armature 805 and back contact of slow relay C^s, conductor 806, conductor 807, armature 808 and back contact of relay K^s, conductors 810 and 811, armature 812, and back contact of relay H^s, conductor 813, winding of rotary magnet 814 to free pole of battery and ground. Magnet 814 rotates the connector into engagement with the first P. B. X. trunk. Slow relay E^s remains energized while the impulses are being transmitted. If the first P. B. X. trunk is busy, test multiples 815 and 816 will be grounded. The ground on multiple 816 is transmitted over test brush 817, conductors 818 and 840, armature 819, and front contact of slow relay E^s, conductor 820, armature 821, and back contact of relay H^s, conductor 822 and relay K^s to free pole of battery and ground. Relay K^s energizes and locks itself in the following circuit: ground, free pole of battery, relay K^s, conductor 822, armature 821, and back contact of relay H^s, conductor 820, contact 824 of relay E^s, armature 825 and front contact of relay K^s, contact 826 of relay C^s to grounded sleeve wire 827. Relay K^s in operating closes the following circuit for relays C^s and G^s: ground, free pole of battery, windings of relays C^s and G^s, armature 827 and front contact of relay K^s, armature and back contact of rotary magnet 814, conductor 828, armature 830, and back contact of relay E^s, conductor 831, test brush 832 to grounded multiple 815. Relay C^s in attracting armature 833 disconnects relay K^s from the grounded sleeve wire and connects relay K^s over conductors 834 and 818 to grounded multiple 816. Relay G^s closes the following circuit for the rotary magnet 814, to rotate the connector on to the next trunk: ground, free pole of battery, winding of rotary magnet 814, conductor 860, conductor 813, armature 812 and back contact of relay H^s, conductor 811, lower armature and front contact of relay G^s, conductor 836 to grounded sleeve wire 837. Rotary magnet 814 at the end of its stroke breaks the circuit of relays G^s and C^s. Relay G^s in retracting its lower armature opens the circuit of the rotary magnet. Relay C^s opens the energizing circuit of relay K^s, which is released when brush 817 reaches the idle trunk. Assuming that this trunk is idle, potential on the test terminal 838 thereof through the bridge cut-off winding of the line is transmitted by brush 817 conductor 818, conductor 840, armature 819 and back contact of relay E^s, conductor 841, the upper winding of relay H^s, conductor 842, upper outer armature and back contact of relay K^s, conductor 843, outer armature and front contact of relay B^s to ground. Relay H^s in attracting its armature 845 locks itself to grounded sleeve wire 837 and extends this ground over conductor 847 to relay D^s which in operating cuts off impulse relay A^s and disconnects grounded sleeve conductor 837 from the control conductor 848, at its armature 849. Thus, the deenergization of relay D^4, (Fig. 4) follows which causes the current to be reversed in the trunk leading back to the toll operator's position, which results in the lighting of the lamp 100 as a ringing signal to the operator. Relay F^s was operated upon the operation of relay B^s when the toll transmission selector seized the connector. The operation of relay D^s in attracting its armature 850 opens the original circuit for the relay F^s but before this relay which is slow can be energized, a substitute circuit is closed over control conductor 848 as described. The armature 854 of relay H^s applies a direct ground over conductor 818 to the test multiple 838 of the seized line and this ground is transmitted by the conductor 855 to the test multiple 856. Thus this trunk will test busy to other connectors. When the operator depresses her ringing key it operates alternating current relay C^4 to energize relay E^4 which removes ground from the control lead and consequently relay F^s releases connecting at its armatures 851 and 852 the ringing machine in circuit with the called line to signal the subscriber. Upon the response of the subscriber relay F^s operates by means of its lower winding and again locks up to grounded control wire 848. Current is fed to the called line relay A^4 and the repeating coil 406 (Fig. 4).

The called subscriber by operating his switch hook flashes the supervisory lamp 100 at the toll operator's position. After the called subscriber replaces his receiver, the operator can, by actuating her ringing key RK, again cause the connector to start the ringing operation until the called party answers. When the called subscriber replaces his receiver, relay A^4 releases, deenergizing relay B^4 which again connects current to the trunk leading back to the operator's position to operate relay B^{43} to light the supervisory lamp 100 permanently as a disconnect signal. The operator thereupon removes the plug which results in the release of the switches as described. The release circuit of the P. B. X. connector is as follows: ground, battery, winding of release magnet 853, lower make contact of off normal switch 802, left hand armature and back contact of relay B^s, lower armature and back contact of relay A^s, armature 800 and back contact of relay D^s to ground. The off normal switch is restored when the connector shaft reaches its normal position.

Relay H^4 is provided to permit the toll operator to manually apply ringing current to the selected private branch exchange line to signal the operator thereat. This relay is operated when the relay E^4 is operated due to the actuation of the ringing key by the toll operator. The circuit for operating relay H^4 extends from grounded battery, winding of relay H^4, left hand contacts of relay E^4 to ground at the contacts of relay A^4. Relay H^4 is not operated when re-ringing on the line, other than a private branch exchange line, because in such a case, there is no bridge across the T and R conductors to energize relay A^4. If relay A^4 is not operated, relay H^4 cannot be operated when relay C^4 is energized because the ground at the contacts of relay A^4 is not in circuit with the winding of relay H^4. In private branch exchange working the called subscriber may hang up his receiver, but due to the bridge at the P. B. X. operator's board the relay A^4 remains operated and thus no signal is given to the toll operator. Circuits for private branch exchanges where a bridge is placed across the operator's cord circuit, when the subscriber at the private branch hangs up his receiver, are old and well known in the art for example, as shown in Patent No. 1,232,507, of July 10, 1917, to H. L. Darrah.

What is claimed is:

1. In a telephone exchange system, the combination with telephone lines, automatic switches, groups of trunk lines terminating therein, an operator's position, a lamp thereat, means controlled from said position for setting said switches to interconnect said lines over said trunks, means controlled by the busy condition of the selected line for flashing said lamp in one manner and means controlled by the busy condition of a selected trunk group for flashing said lamp in another manner.

2. In a telephone exchange system, the combination with an automatic office including automatic switches, subscribers lines terminating therein, a toll operator's position including a cord circuit having a supervisory lamp therein, a dial associated therewith, means actuated in case one of said switches fails to find an idle trunk for flashing said lamp in a certain manner, and means actuated in case the connector finds the selected line busy for flashing said lamp in a different manner.

3. In a telephone exchange system, the combination with telephone lines, automatic switches, groups of trunks terminating therein, an operator's position, a lamp thereat, means at said position for controlling said switches to interconnect said lines over said trunks, means controlled by the idle condition of the selected line for lighting said lamp as a ringing signal, means controlled by the operator for causing ringing current to be applied to the selected line, means controlled by the response of the called party for cutting off the ringing current, means controlled by the busy condition of a selected trunk group for flashing said lamp at a certain rate, and means controlled by the busy condition of the called line for flashing said lamp at a different rate.

4. In a telephone exchange system, the combination with telephone lines, automatic switches, groups of trunks terminating therein, an operator's position, means at said position for controlling said switches to interconnect said lines over said trunks, a supervisory lamp at said position a supervisory relay controlling the same, a polarized relay bridged across one of said trunks, means controlled by the idle condition of the selected line for operating said polarized relay to cause the energization of said supervisory relay, means controlled by the busy condition of said line for closing an interrupted circuit through said supervisory relay to flash said lamp at a certain rate, and means controlled by the busy condition of a selected trunk group for closing an interrupted circuit to intermittently energize said supervisory relay to flash said lamp at a different rate.

5. In a telephone system, telephone line, automatic switches, a trunk circuit, an operator's position, a cord circuit thereat having means for controlling said switches to build up a connection over said trunk lines to a selected line, a supervisory lamp in said cord, a supervisory relay in said cord, a polarized relay in one of said trunks, means controlled by the idle condition of the selected line for operating said polarized relay to close the circuit of said supervisory relay, means controlled by the busy condition of the selected line for preventing the operation of said polarized relay and for closing an interrupted circuit to said supervisory relay to flash said lamp at a certain rate, and means controlled by the busy condition of a selected trunk group for closing an interrupted circuit to said supervisory relay to flash said lamp at a different rate.

6. In a telephone system, the combination with telephone lines, groups of trunk lines including automatic switches, an operator's position, means at said position for building up a connection to a called line over said trunks and switches, a supervisory signal at said position, a supervisory relay therefor, a key at said position, an interrupted circuit for said relay prepared during the building up of a connection, a second interrupted circuit, means controlled by the busy condition of the called line and said key for connecting said first circuit to said relay to

flash said lamp at one rate, and means controlled by the busy condition of a selected trunk group and said key for connecting said second circuit to said relay to flash said lamp at a different rate.

7. In a telephone system, the combination with telephone lines, groups of trunks including automatic switches, an operator's position, means at said position for building up a connection over a called line, trunks and switches, a supervisory lamp at said position, a key at said position, a supervisory relay therefor, a circuit for interrupting said supervisory relay controlled by a contact of said key, said key being actuated to render said circuit inoperative while impulses are being transmitted to said switches, said circuit being closed to flash said lamp at a given rate when said key is restored and the selected line is found busy, and a relay actuated by the busy condition of a selected trunk group for substituting an interrupted circuit which is closed when said key is restored to flash said lamp at a different rate.

8. In a telphone system, the combination with telephone lines, groups of trunks including automatic switches, an operator's position, means at said position for building up a connection to a called line over said trunk and switches, a supervisory lamp, at said position, a supervisory relay therefor, a circuit for interrupaing said supervisory relay controlled by a contact of said key, said key being actuated to render said circuit inoperative while impulses are being transmitted to said switches, said circuit being closed to flash said lamp at a given rate when said key is restored and the selected line is found busy, a relay actuated by a busy condition of a selected trunk group for substituting an interrupted circuit which is closed when said key is restored to flash said lamp at a different rate, and a polarized relay operated due to the idle condition of the called line for permanently opening said first named interrupted circuit.

9. In a telephone system, telephone lines, an operator's cord circuit, a supervisory relay bridged across said circuit, a supervisory lamp controlled thereby, a dialing key in said cord circuit, a relay controlled thereby for opening one side of the cord and substituting said dial, a shifting relay in said trunk in its normal position preparing a circuit to intermittently operate said supervisory relay, the restoration of said dialing key deenergizing said relay to close said cord whereby said supervisory relay is intermittently operated to flash said lamp if the selected line is busy, means for operating said shifting relay to prepare a substitute circuit for said supervisory relay which is closed upon the restoration of the dialing key if one of said switches finds a trunk group busy, and means controlled by the idle condition of the selected line for disconnecting said interrupted circuits from connection with the supervisory relay.

10. In a telephone system, telephone lines, automatic switches, trunk groups, an operator's position, a lamp thereat, a dial at said position for building up a connection to a called line over said trunks and switches, a dialing key, means controlled by the busy condition of the selected group for flashing said lamp at a certain rate upon the restoration of said dialing key, and means controlled by the busy condition of the selected line for flashing said lamp at a different rate upon the restoration of the dialing key.

11. In a telephone system, the combination with telephone lines, automatic switches, groups of trunks, an operator's position, a supervisory lamp thereat, a dial at said position for building up a connection to a called line over said trunks and switches, a dialing key for connecting said dial to said trunk and for disconnecting said supervisory relay therefrom, means controlled by the busy condition of a selected group for flashing said lamp at a certain rate upon the restoration of said dialing key, and means controlled by the busy condition of the selected line for flashing said lamp at a different rate upon restoration of said dialing key.

12. In a telephone system, the combination with telephone lines, automatic switches and groups of trunks, an operator's position, a dial thereat for building up a connection over said trunks and switches, a supervisory relay thereat, a lamp controlled thereby, said dialing key when actuated disconnecting said supervisory relay, means controlled by the idle condition of the selected line and the restoration of said key for lighting said lamp, if the selected line is idle, means controlled by the busy condition of a selected trunk group and the restoration of said key for flashing said lamp at a certain rate, and means controlled by the busy condition of the selected line and restoration of said key for flashing said lamp at a different rate.

13. In a telephone system, telephone lines, automatic switches, groups of trunks, an operator's position, a supervisory lamp thereat, a dial, a dialing key for connecting said dial to said circuit to build up a connection to a called line over said trunks and switches and to simultaneously open the circuit of said supervisory lamp, a circuit prepared by the finding of a selected group busy and closed upon the restoration of the dialing key for flashing said lamp at a certain rate, a second circuit prepared due to the busy condition of the selected line and closed by the restoration of the key for flashing said lamp at a different rate, and means controlled by the idle condition of

the selected line for preventing the closure of either of said circuits.

14. In a telephone system, the combination with telephone lines terminating in different offices, automatic switches, groups of trunks, an operator's position, a supervisory relay and lamp thereat, a dial for controlling said switches to build up a connection from one office to a called line in another office over one of said trunks, means controlled by the idle condition of the called line for applying current to said trunk to operate said supervisory relay to light said lamp, means controlled by the response of the called party for removing battery from the trunk to deenergize said relay to extinguish said lamp and means controlled by the busy condition of a selected group to flash said lamp.

15. In a telephone system, the combination with telephone lines terminating in different offices, automatic switches, groups of trunks, an operator's position, a supervisory relay and lamp thereat, a dial for controlling said switches to build up a connection from one office to a called line in another office over one of said trunks, means controlled by the idle condition of the called line for applying current to said trunk to operate said supervisory relay to light said lamp, means controlled by the response of the called party for removing current from the trunk to deenergize said relay to extinguish said lamp, and means controlled by the replacement of the receiver by the called party for again applying current to said trunk to operate said supervisory relay to light said lamp, means controlled by the busy condition of a selected trunk group to flash said lamp at a given rate, and means controlled by the busy condition of a selected line for flashing said lamp at a different rate.

In witness whereof, I hereunto subscribe my name this 23 day of April A. D., 1923.

RAY L. STOKELY.