

Dec. 22, 1931.

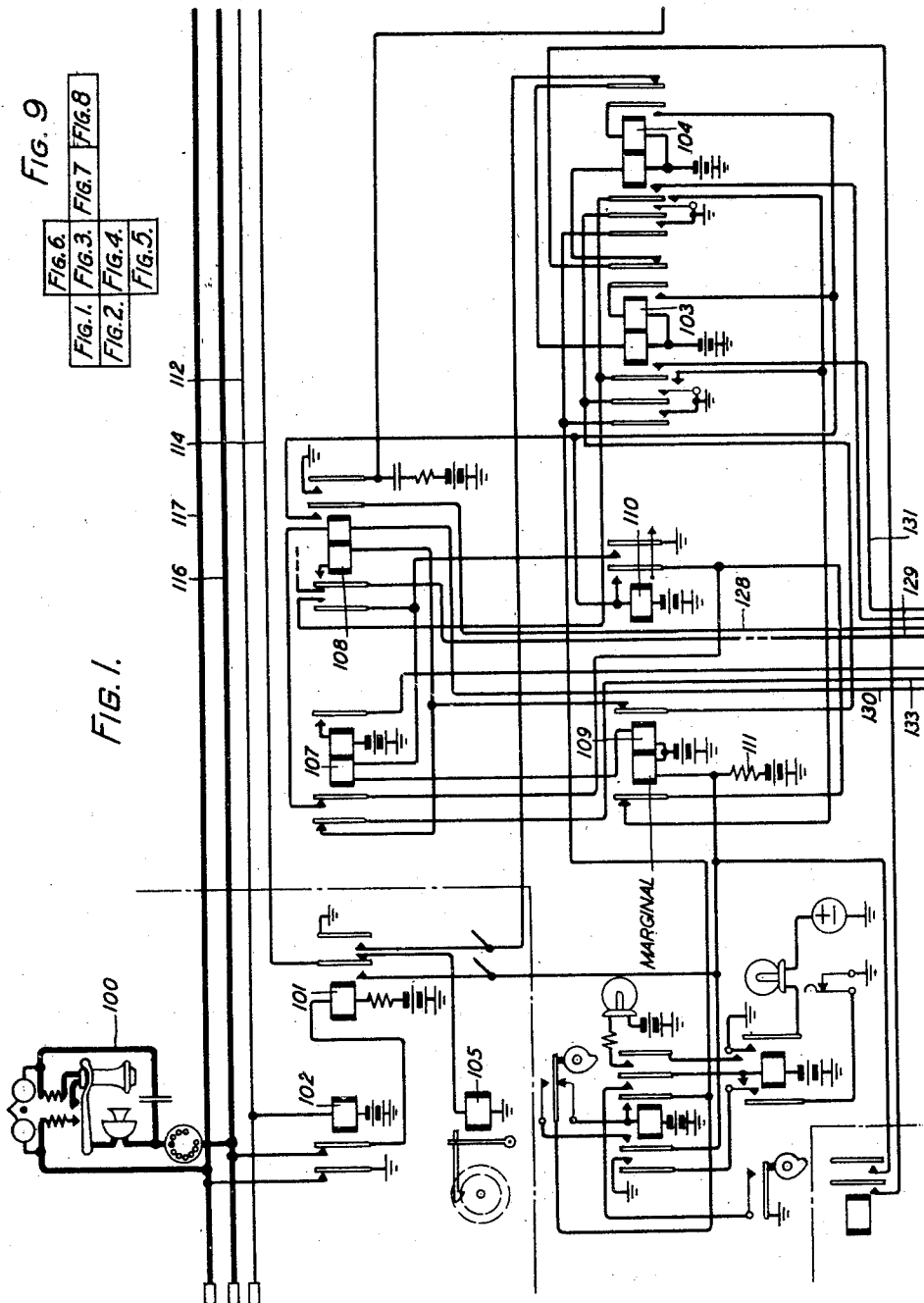
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1,837,206

CALL CHARGING TELEPHONE EXCHANGE SYSTEM

Filed June 26, 1930

8 Sheets-Sheet 1



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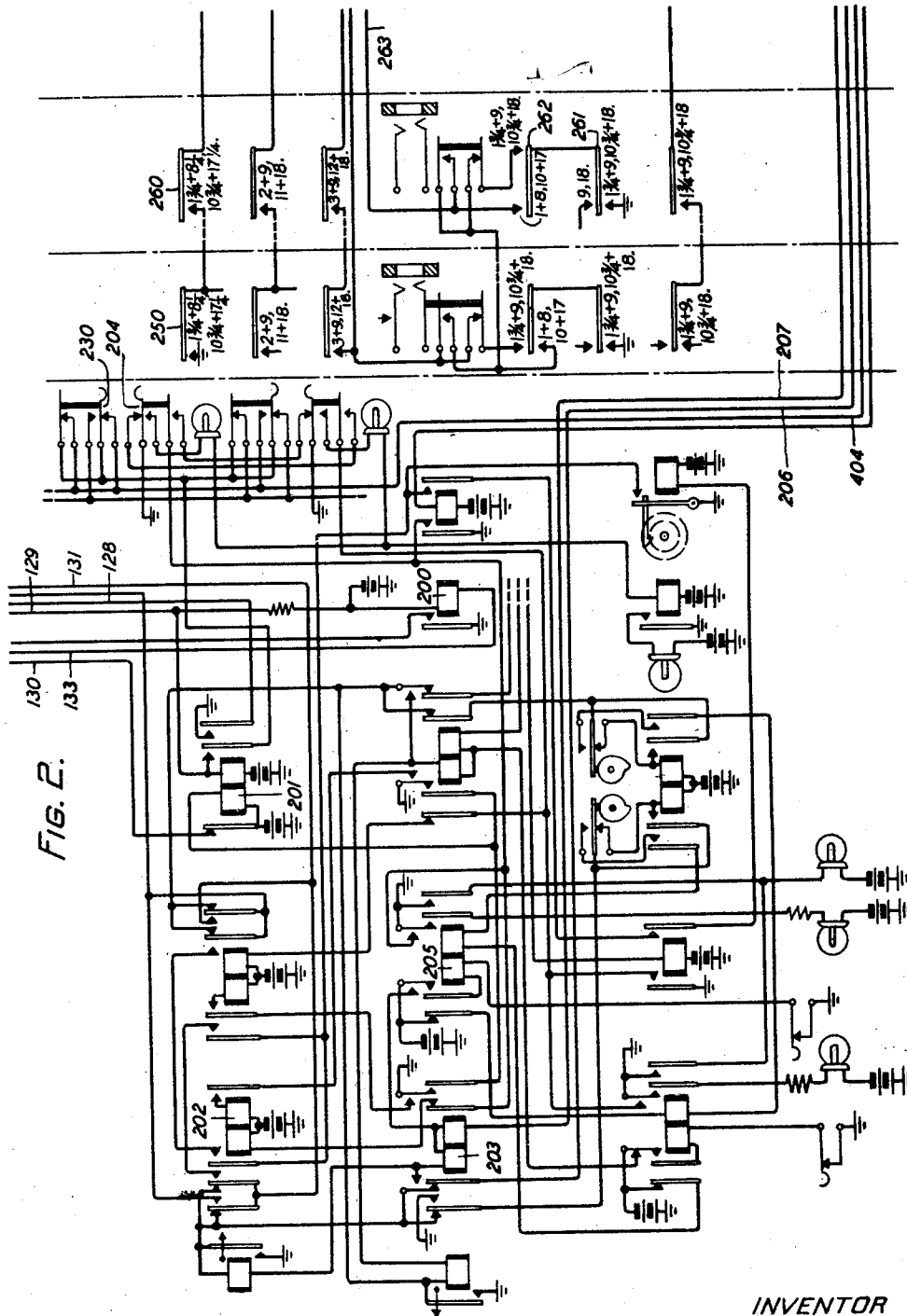
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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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8 Sheets-Sheet 2



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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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8 Sheets-Sheet 3

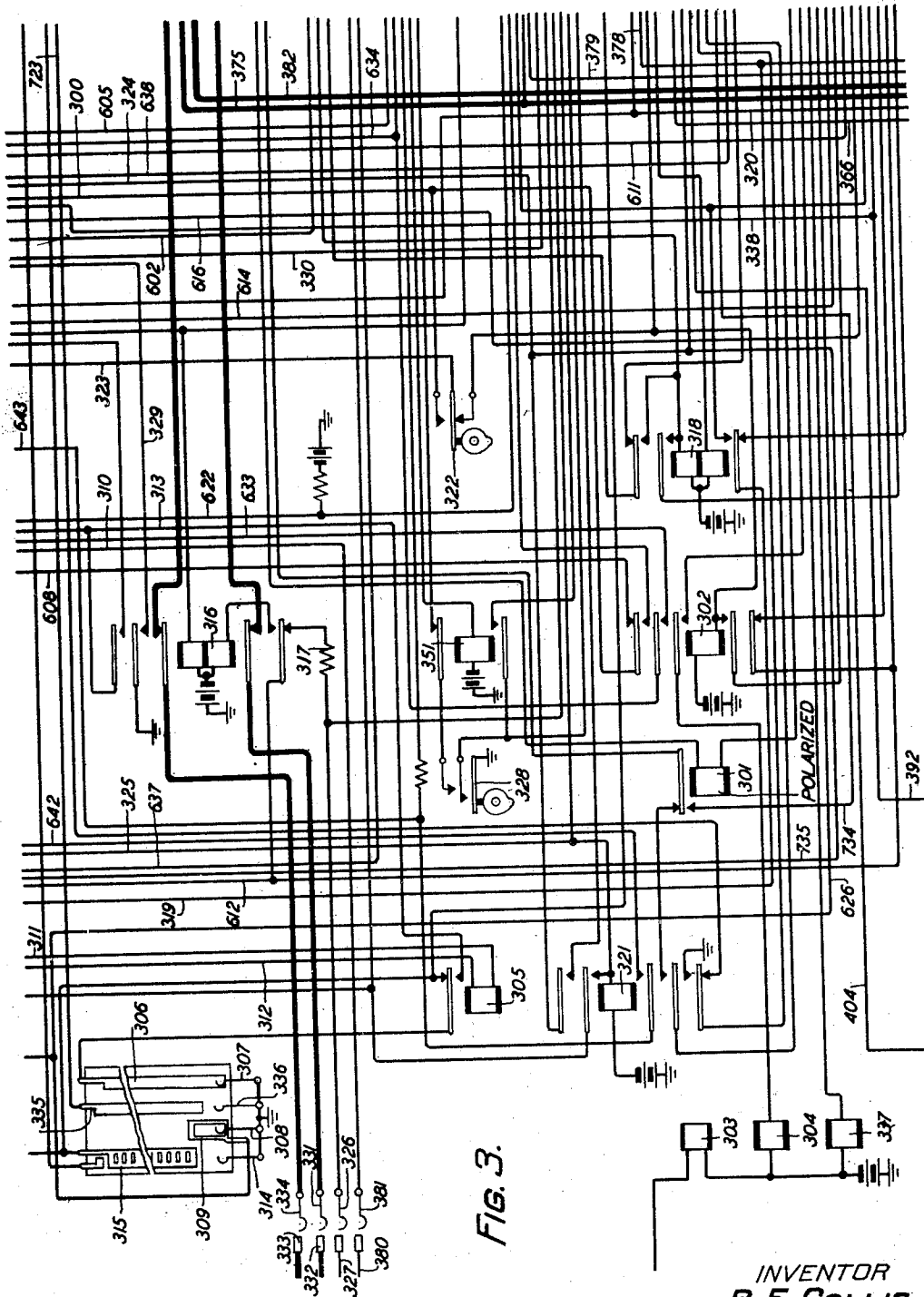


FIG. 3.

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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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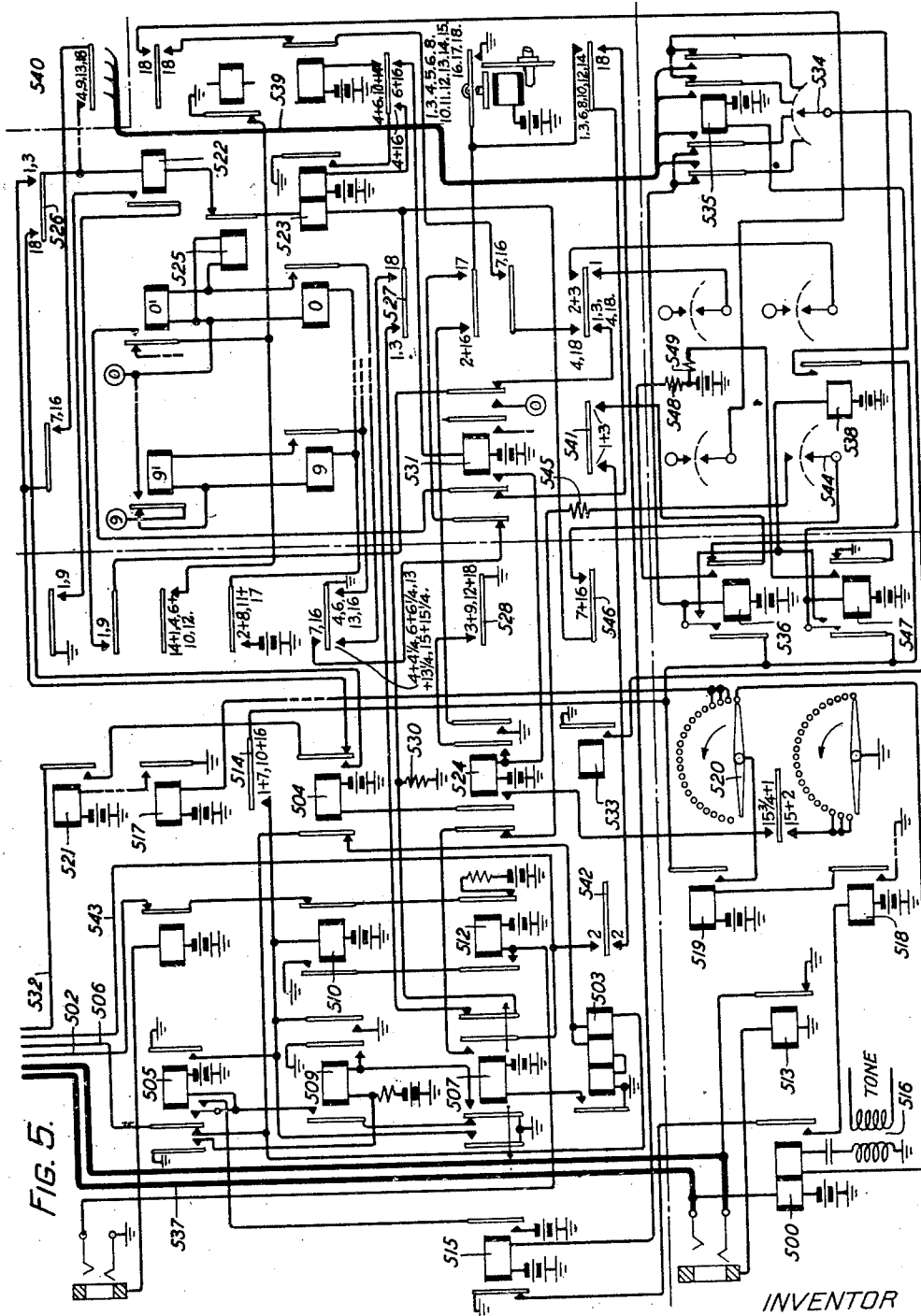


FIG. 5.

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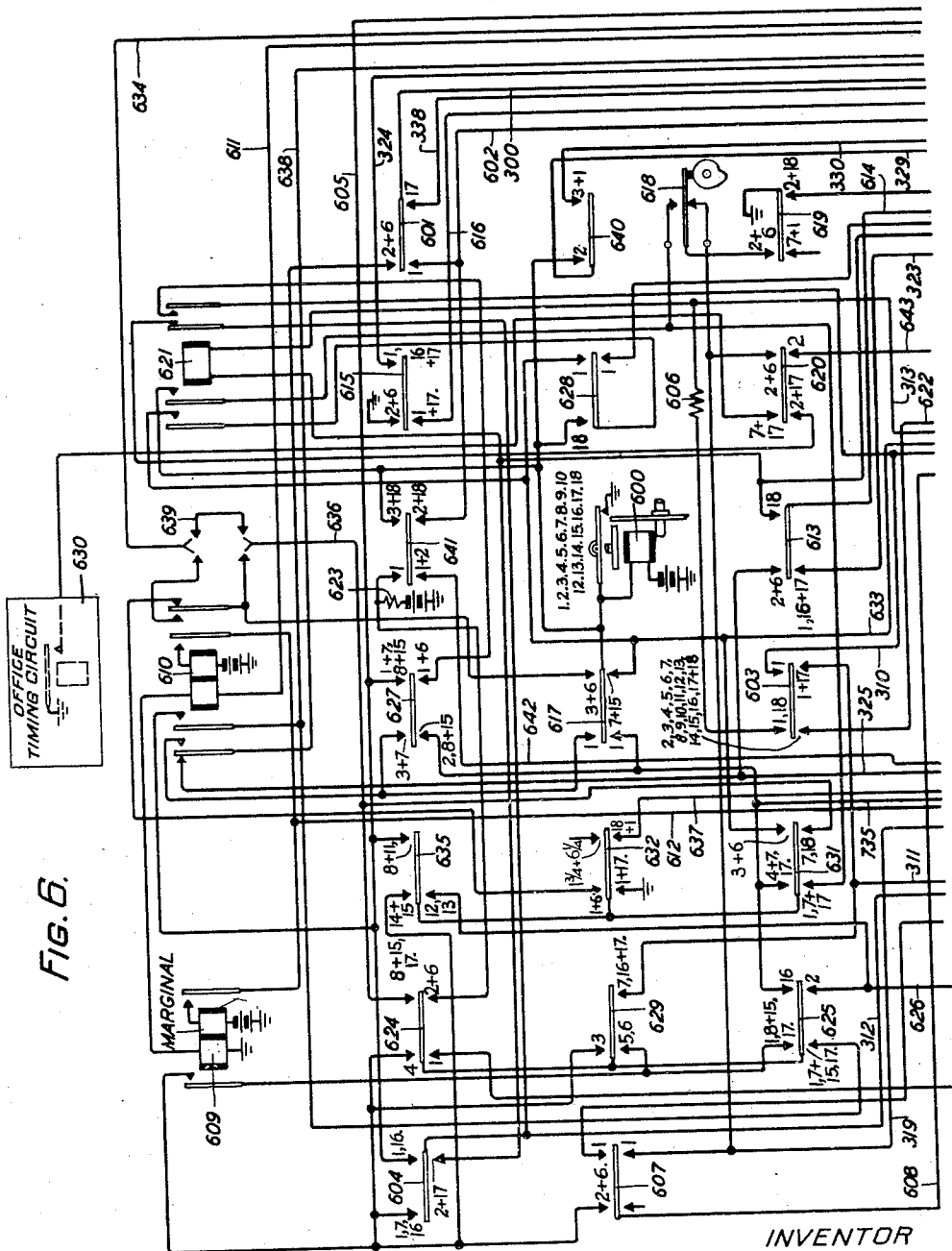
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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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8 Sheets-Sheet 6



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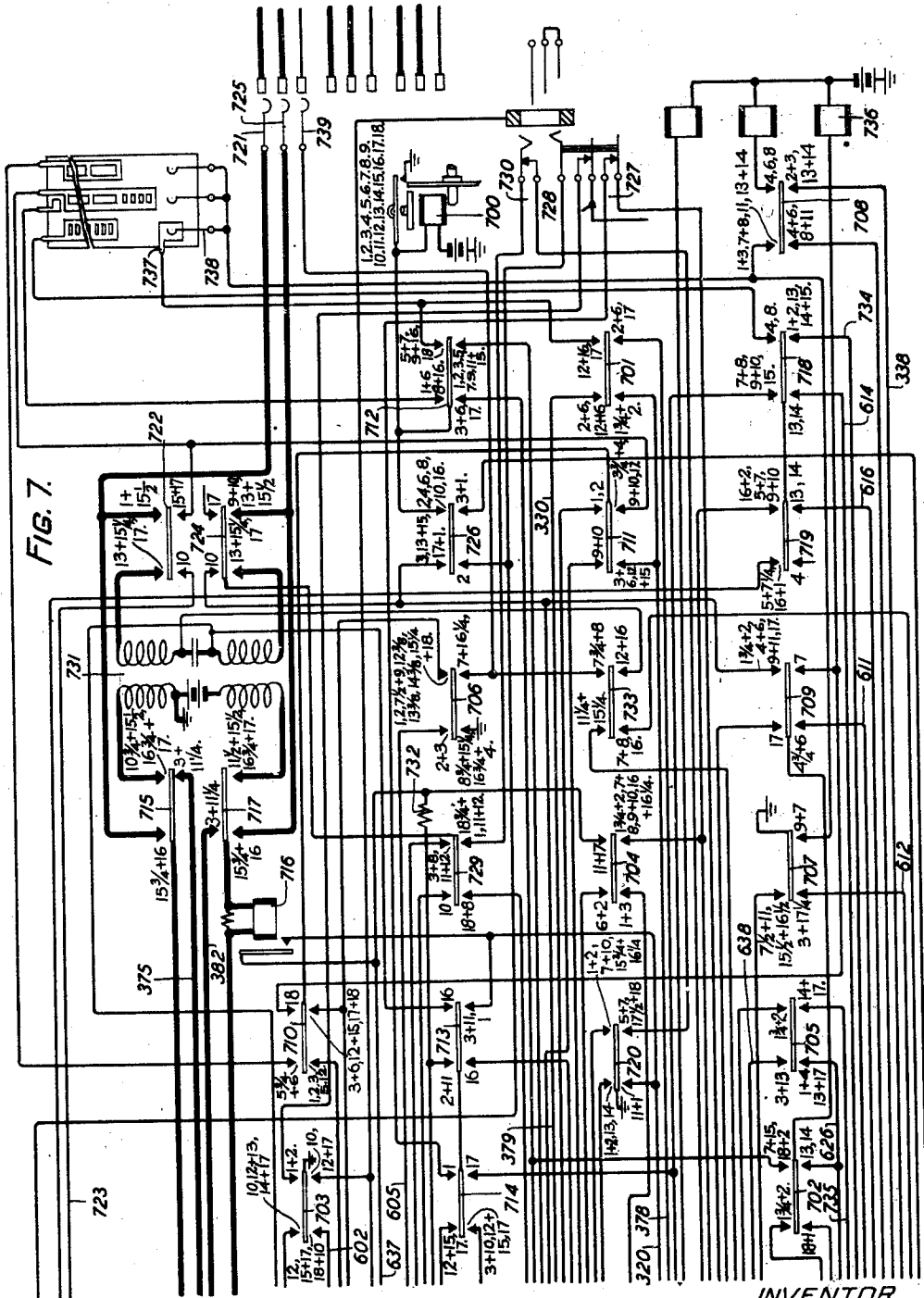
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8 Sheets-Sheet 7



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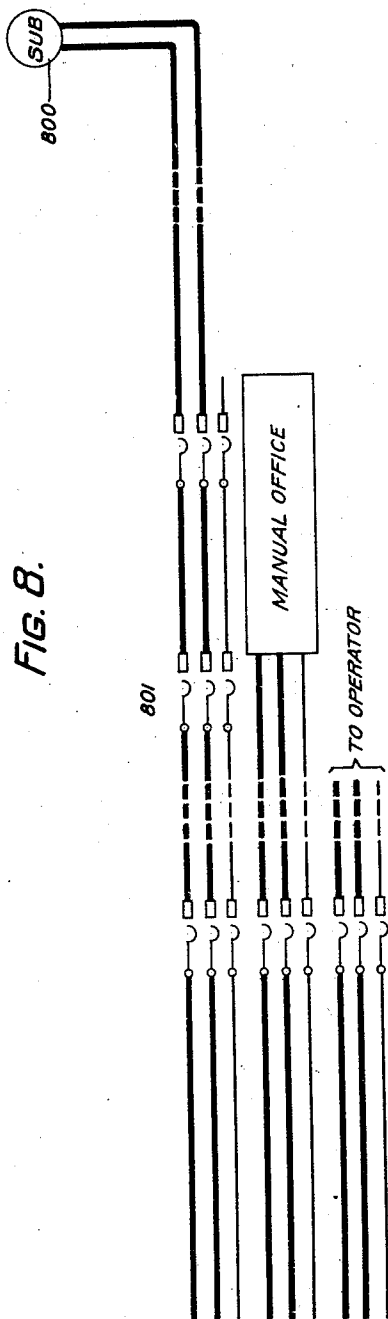
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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

Application filed June 26, 1930. Serial No. 463,945.

This invention relates to a telephone exchange system and more particularly to a system in which a charge is automatically made for a completed call. The object of the invention is the provision of means for controlling the call charging in such a manner as to more equitably recompense the operating company for the use of exchange equipment, but without overcharging the subscriber in the event of defective circuit operation.

In large exchange areas having several offices some of which may be located at very distant points in the area, it is desirable that means be provided whereby a calling subscriber may be charged differently for calls to offices which are most remotely located from the office in which the calling line terminates than for calls to offices which are not so remotely located, since the remotely located offices must be reached over long inter-office trunks which are expensive to install and maintain and it is not equitable to the operating company to provide service to all points in the exchange area at the same basic rate.

Where calls are handled on a manual basis, the rate of charge may be very easily cared for by the operator who is able to require the calling subscriber to deposit the required number of coins in his coin box before giving him a desired connector, or to cause the proper operation of the subscriber's message register. However, where calls are established entirely by dial switching means, some provision must be made for automatically controlling the charging of the call in accordance with the zone of the exchange into which the call has been extended by the calling subscriber.

Furthermore, it is not equitable to the operating company that for a basic charge the subscriber shall be enabled to hold an established connection indefinitely. In manual systems the operator is able to assess the charge in accordance with the number of unit periods during which conversation is continued on any call. Where, however, calls are extended by means of a dial switching system, operator supervision is not desirable and from a standpoint of economy, charging for overtime periods of conversation should be attained by automatic means.

Both automatic charging in accordance with the zone of the exchange area into which a call is extended and in accordance with the elapsed conversational period have been heretofore accomplished. In accordance with the present invention, however, one specific embodiment of which is disclosed herein by way of example, provision is made whereby the charges for overtime periods of conversation may be made in accordance with the zone into which the call has been extended and on a different basis than the charges for the initial period of conversation. This is accomplished by the provision of a timing switch individual to a line finder district selector link which is started upon the response of the called subscriber and advances through a cycle to measure the prescribed unit period for conversation, the unit period having been chosen as that which would be proper for a single unit charge, for example, five minutes. The timing switch during the initial portion of its cycle transmits impulses to the calling subscriber's message register, the number of register operations depending upon the zone of the exchange into which the calling subscriber has extended the connection.

The number of registering impulses which the timing switch sends during each cycle is controlled by two zone recording relays which are controlled by the district selector sequence switch and by the register sender, the sequence switch assuming different positions dependent on the zone into which the call is extended. By the provision of two zone recording relays charging for six zones may be controlled.

During the latter portion of the first or initial cycle of the timing switch the prescribed time for the initial period of conversation is counted. If the conversation continues after the timing switch has completed its initial cycle, for example, after the elapse of five minutes, the timing switch tests to see if the connected subscribers are still conversing and is then started upon a second cycle. At this time, however, the circuits of the timing switch are altered in such a manner that during the first portion of the second cycle the impulses which are transmitted to operate the calling subscriber's message register are transmitted on a different basis than for the initial period of conversation. In the modification of the invention chosen for illustration the message register operations for calls to zones 0, 1, 2, 3, 4 and 5 are none, one, two, three, four and five respectively, for the initial period of conversation; whereas for the overtime period of conversation, the message register is not operated for calls to zone 1, but is operated once for calls to the other zones. By slight changes in the wiring of the timing circuit the charging impulses may be varied at will to meet the traffic requirements of the particular exchange in which the equipment is installed.

As the timing switch advances through the latter part of its second or overtime cycle, it measures the prescribed time for the overtime period of conversation. This overtime period may be varied in accordance with the zone into which the call has been extended or may be made uniform for all calls. In the modification illustrated the overtime periods are varied in accordance with the zones and may, for example, for zones 0, 1, 2, 3, 4 and 5 be no limit, five minutes, three minutes, two minutes, two minutes and one minute respectively. If the conversation continues after the completion of the second cycle of the timing switch, the timing switch will advance through additional overtime cycles as long as the conversation continues and will continue to operate the subscriber's message register for each such cycle.

In order to guard against false charging and undertiming due to trouble crosses and trouble grounds in the timing circuit and in the line finder district selector link, safeguards have been incorporated into the circuits which serve to prevent excessive charging or undertiming of the periods of conversation when a trouble condition arises. By this provision a subscriber always receives the full measure of service to which he is entitled for the charge which is registered on his message register.

A clearer conception of the scope and purpose of the invention will be obtained from a consideration of the following description in

connection with the attached drawings in which:

Fig. 1 shows a calling subscriber's line together with certain relays common to groups of calling lines.

Fig. 2 shows a start circuit and a portion of two link circuits.

Figs. 3 and 7 show a line finder district selector link circuit, Fig. 3 showing the line finder and Fig. 7 the district selector.

Fig. 4 shows a link circuit for associating a sender with the district selector.

Fig. 5 shows a skeletonized disclosure of a register sender.

Fig. 6 shows a timing switch individual to the line finder district selector link circuit of Figs. 3 and 7 for controlling the calling subscriber's message register.

Fig. 8 shows in schematic form selectors for completing a connection to an automatic subscriber's line, to a manual office or to an operator's position.

Fig. 9 shows the manner in which Figs. 1 to 8 should be arranged.

The invention has been embodied in a disclosure which is similar to that of U. S. Patent 1,567,072 granted to W. H. Matthies December 29, 1925, both the present disclosure and that of the Matthies patent showing a skeletonized sender substantially the same as that disclosed in the more complete disclosure of U. S. Patent 1,589,402 granted to O. H. Kopp June 22, 1926 and reference to the Kopp patent is made for operations not completely described herein.

As disclosed in the above mentioned patents, a plurality of link circuits is arranged to serve a group of calling lines and are taken into service in rotation. When a link circuit completes its function it hunts for and associates itself with a district selector which is ready for use and the link and district remain in a sub-allotted condition until the next link in the series has been put into service. The link circuit is then put into an allotted condition from which it will be advanced by the initiation of a call and the action of the start circuit of Fig. 2. The trip circuit of Fig. 1 and start circuit of Fig. 2 are so arranged that only one line may be served at a time and so that there may be cooperation between two groups of lines to each of which a group of link circuits is individual. The details of these functions are described in the above mentioned Matthies patent and since they form no part of the present invention will be omitted from the following description.

Establishment of a connection

It will be assumed that the subscriber at substation 100 first initiates a call for which he is to be charged five times for the first five minutes of conversation. When the subscriber at substation 100 removes his receiver from the switchhook a circuit is closed from battery

through the winding of relay 101, back contact of relay 102 over the subscriber's line to ground at the outer contact of relay 102. Relay 101 in operating closes a circuit from battery, winding of relay 103, right back contact of relay 104, to ground at the outer front contact of relay 101. It also prepares a circuit from battery through resistance 111 and the left winding of marginal relay 109 in parallel, inner front contact of relay 101 to conductor 114 to identify the calling line to the line finder. Relay 103 in operating closes a circuit from battery over the back contact of relay 201, conductor 130, right winding of relay 108, inner back contact of relay 107, back contacts of relay 109, middle left contact of relay 103 to ground.

Relay 108 operates in this circuit and closes a locking circuit for itself from battery through the right winding of relay 201, conductor 129, over back contacts of relays similar to relay 108, individual to other groups of lines appearing before the same line finder, inner left front contact and left winding of relay 108, the right back contact of relay 109 to ground at the middle left front contact of relay 103. Relay 108 prepares a circuit from ground at its outer right front contact through the winding of trip magnet 303 of the line finder to battery in preparation for tripping the proper set of brushes when the line finder is operated. Relay 201 operates in the locking circuit of relay 108 and in combination therewith closes a circuit from ground over its outer right contact, conductor 128, inner right contact of relay 108, winding of relay 110, to battery. Relay 110 locks over its inner right contact, the left back contact of relay 109 to ground at the middle left front contact of relay 103. Relay 110 closes a circuit for starting the allotted line finder.

Assuming that the link and line finder shown are the ones to be used next, sequence switch 400 will be standing in position 1 and sequence switch 700 in position 2. The operation of relay 110 will therefore close a circuit from ground at its outer right contact, outer left front contact of relay 108, inner left front contact of relay 103, conductor 131, left back contact of relay 202, inner left back contact of relay 203, conductor 206, upper left and lower right contacts of cam 403, brush 402 and terminal 401, conductor 378, lower contacts of cam 701, winding of relay 302 to battery.

Relay 302 upon operating closes a circuit from battery through the winding of up-drive magnet 304 of the line finder, inner upper contact of relay 302, upper contacts of cam 702, upper front contact of relay 302, conductor 300, lower left contact of cam 601, conductor 602, lower left contact of cam 703, to ground. Relay 302 also locks over its inner lower front contact, the lower contacts of cam 704, the back contact of relay 305,

commutator segment 306 to ground on brush 307. The line finder moves upwardly under the control of magnet 304 and since the trip magnet 303 is operated the proper set of brushes is tripped. As soon as commutator brush 308 engages segment 309 a circuit is closed thereover, conductor 626, the lower left and upper right contacts of cam 705, conductor 404, contact 230 of key 204, inner right front contact of relay 201 to conductor 129 and the right winding of relay 201. This circuit shunts the winding of relay 108 and causes that relay to release in turn releasing the trip magnet 303. When brush 308 leaves segment 309 the circuit of relay 201 is opened and that relay also releases. When line finder brush 381 makes contact with terminal 380 which is connected over conductor 114 to battery, a circuit is completed over conductor 310, right contacts of cam 603, conductor 311, winding of relay 305, conductor 312, upper right contact of cam 604, conductor 605, to ground over the left contacts of cam 706. Relay 305 operates in this circuit and closes a shunt around its winding from ground over commutator brush 307 and segment 306, front contact of relay 305, conductor 313, resistance 606, upper left and lower right contacts of cam 603, thence as traced through the winding of relay 305, to ground at the left contacts of cam 706. This shunt circuit reduces the resistance in series with the winding of marginal relay 109 sufficiently to cause that relay to operate and to open the locking circuit of relay 110 which in turn opens the energizing circuit of relay 302. The operation of relay 305 also opens one locking circuit of relay 302 causing that relay to release as soon as the line finder brushes become centered on the terminals of the calling line and commutator brush 314 engages an insulating portion of centering segment 315. The release of relay 302 opens the circuit of the updrive magnet to arrest the hunting movement of the line finder and connects ground from the right contact of cam 707, upper left and lower right contacts of cam 708, conductor 338, lower back contact of relay 302, lower back contact of relay 316, resistance 317, brush 326, terminal 327, conductor 112 to battery through the winding of cutoff relay 102. Relay 102 thereupon operates disconnecting the line relay from the calling line which upon releasing in turn releases relay 109.

At the time relay 302 operated it closed a circuit from ground at the lower left contact of cam 703 over conductor 602, the lower left contact of cam 601, conductor 300, the upper front contact of relay 302, the upper right contact of cam 702, the upper right contact of cam 709, conductor 379, terminal 407 and brush 406 of the link district finder 410, lower right contact of cam 408, winding of relay 409, resistance 411 to battery. Relay 409 operates and closes a circuit from battery through

the winding of sequence switch magnet 400, upper contact of cam 412, to ground at the outer left front contact of relay 409 advancing the link sequence switch 400 to position

2. When switch 400 leaves position 1 relay 409 releases. In position 2 a circuit is closed from battery through the winding of relay 413, upper left and lower right contacts of cam 414, right back contact of relay 415, to ground at the right contact of cam 416. Relay 413 operates closing a circuit from battery through the left winding of relay 417, right front contact of relay 413 to ground at the left back contact of relay 415. Relay 417 in operating closes a circuit from battery through the winding of updrive magnet 418 of the sender finder 420, left contact of cam 479, outer right contact of relay 417 to ground at the left back contact of relay 409. The sender finder moves upwardly under the control of magnet 418 in search of an idle sender.
- Relay 413 also closes a circuit from battery through the right winding of relay 415, left contacts of cam 421, middle winding of relay 415, to ground at the inner left contact of relay 413. The current in this circuit, however, is not sufficient to operate relay 415 but does create a flux in its magnetic circuit so that it becomes quick to operate when the test circuit is later closed. The test circuit extends from brush 422 over the lower contacts of cam 419, right back contact of relay 409, left winding of relay 415, upper right and lower left contacts of cam 421, middle winding of relay 415 to ground at the left contact of relay 413. An idle sender is characterized by battery connected to conductor 502. When, therefore, brush 422 engages terminal 423 corresponding to the sender of Fig. 5 which is assumed to be idle, the test circuit above traced is completed over terminal 423 to battery and relay 415 operates quickly. Relay 415 in operating closes a locking circuit for itself from battery through its right winding left contacts of cam 421 to ground at the left front contact of relay 415. It also opens the circuit of relay 417 which releases to in turn release magnet 418 and bring the sender finder to rest on the terminals of the idle sender. The release of relay 417 in turn releases relay 413. With relay 413 released and relay 415 operated a circuit is closed from battery through the winding of sequence switch magnet 400, upper left contact of cam 476, contact 427 of jack 428, left back contact of relay 413, right front contact of relay 415 to ground at the right contact of cam 416, advancing sequence switch 400 to position 3.

- When the link circuit advances into position 2 for hunting for an idle sender a circuit is closed for relay 318 extending from battery through the upper winding of this relay, lower left contact of cam 710, upper right contact of cam 711, conductor 375, terminal

477 and brush 478 of district finder 410, to ground at the right contact of cam 429. With relay 302 released and relay 318 energized a circuit is closed for advancing sequence switch 700 into position 3 which may be traced from battery through magnet 700, the lower right contact of cam 712, the lower front contact of relay 318, conductor 319, lower contact of cam 607, conductor 608, upper back contact of relay 302, conductor 300, the lower left contact of cam 601, conductor 602, to ground at the lower left contact of cam 703. As sequence switch 700 advances from position 2 to 3 relay 318 releases. With sequence switch 700 in position 3 busy ground is applied to the sleeve conductor 115 over line finder brush 326, resistance 317, lower back contact of relay 316 to ground at the lower left contact of cam 707.

When sequence switch 400 reaches position 3 a circuit is closed from ground through the left and middle windings of relay 503, back contacts of relay 504 and 505, conductor 506, terminal 430, brush 431, upper contact of cam 434, brush 432, terminal 433, conductor 320, lower right and upper left contacts of cam 713, assuming that the district selector sequence switch 700 has now advanced to position 3, through the winding of relay 351 to battery, and in parallel over the lower left contact of cam 714 to battery through the upper winding of relay 316. Relay 316 is marginal and does not operate. Relay 351 operates but is ineffective at this time. Relay 503 also operates and closes an obvious circuit for relay 507 which in turn closes a circuit for relay 509. Relay 509 closes a circuit for relay 510.

As soon as sequence switch 400 arrived in position 2 $\frac{3}{4}$ it prepared the pulsing circuit for receiving dial pulses. This circuit may be traced from battery through the left winding of relay 500, conductor 537, terminal 440, brush 441, lower contact of cam 429, brush 478, terminal 477, conductor 375, lower contact of cam 715, upper back contact of relay 316, brush 334, terminal 333, conductor 117 through the subscriber's substation, conductor 116, terminal 332, brush 331, inner lower back contact of relay 316, winding of relay 716, upper contact of cam 717, conductor 382, terminal 442, brush 443, upper right and lower left contacts of cam 403, brush 444 and terminal 445, to ground at the back contact of relay 513. Relay 500 operates in turn operating relay 518 in the well known manner, relay 518 in turn operating relay 519. A circuit is thereupon closed from the source of tone current 516 through the right winding of relay 500, switch 520 in its normal position, front contact of relay 519, contact of cam 514 to ground at the front contact of relay 509. This tone is transmitted to the calling subscriber to inform him that the

sender is ready to receive impulses which he may then send by manipulating his dial.

When relay 510 operated it removed battery from conductor 502, releasing relay 415.

5 With relay 415 released a circuit is closed from battery through the winding of sequence switch magnet 400, lower left contact of cam 476, right back contact of relay 415, to ground at the right contact of cam 416. Sequence switch 400 advances to position 5 over this circuit and remains in this position throughout the further operation of the sender.

15 The calling subscriber now proceeds to dial the desired line number for setting the registers and translator (not shown) of the sender in the well known manner. After dialing the first digit the switch one wiper of which is shown at 520 advances from normal closing a circuit extending from battery through the winding of relay 517, terminals and wiper 520, contacts of relay 519, contact of cam 514, to ground at the outer right contacts of relay 509. Relay 517 closes an obvious circuit for relay 521.

As soon as the code registers of the sender have been set in accordance with the first two digits dialed by the calling subscriber, the translator is set in a manner described in the aforementioned patent to O. H. Kopp. When the translator assumes its setting, relay 533 operates and circuits are prepared over the translator arc 534 through a back contact of relay 535 for operating either relay 536 or relay 547 or neither of them dependent upon in which zone of the exchange the wanted line is located. For example, if a called number is dialed for either zone 0 or zone 1, neither relay 536 or 547 will be operated. If a call is dialed for either zone 2 or zone 3, relay 536 will be operated and if the call is for either zone 4 or zone 5, relay 547 will be operated. It will be assumed that a call is for a subscriber's line terminating in the fifth zone and that therefore relay 547 is operated over a circuit extending from battery, winding of relay 547, back contact of relay 535, translator arc 534 to ground at the contact of relay 533. Relay 547 locks over its left front contact, the contact of cam 514 to ground at the outer right front contact of relay 509 and extends its locking ground to the winding of relay 538. Relay 538 upon operating establishes a circuit from ground at the outer right contact of relay 509 over the contact of cam 514, the contact of relay 538 to battery through the winding of relay 535. Relay 535 operates opening the initial energizing circuit of relay 547 and connecting the translator arc 534 over a cable 539 to the class switch 540, which is diagrammatically indicated in the upper right portion of Fig. 5. The class switch is thereupon set from the arc 534 of the translator. With relay 547 operated and relay 536 non-operated, a circuit

is prepared extending from battery through low resistance 549, right front contact of relay 547, right back contact of relay 536, the contacts of cams 541 and 542, these cams being closed during the district brush selection positions of the sequence switches associated with the sender, conductor 543, terminal 439, brush 438, right contacts of cam 405, brush 406, terminal 407, conductor 379 to the upper right contact of cam 709. This circuit is completed as will be described hereinafter when the district sequence switch is advanced to position $4\frac{3}{4}$ through the left windings of zone relays 609 and 610 of the registration controlling circuit of Fig. 6 for indicating the fact that the subscriber has directed the call to a particular zone of the exchange, in the case assumed, the fifth zone. It may be noted at this time that due to the inclusion of the low resistance 549 both zone relays 609 and 610 will operate. Had relay 536 in the sender been operated, then battery through high resistance 548 would have been connected with the circuit just traced and only relay 610 would then be operated as soon as the district sequence switch reaches position $4\frac{3}{4}$. If neither relay 536 or 547 operate then direct ground is connected to the circuit prepared through the windings of relays 609 and 610 and neither of the latter relays will operate.

With sequence switch 700 in position 3 relay 318 is energized over a circuit extending from battery through its upper winding, the lower left contact of cam 710, the lower left contact of cam 711, conductor 378, terminal 401 and brush 402 of district finder 410, the upper contacts of cam 435, brush 436 and terminal 437 of sender finder 420, the contact of relay 521, the back contact of relay 504, the right contact of cam 526, winding of sender stepping relay 522, back contact of relay 525, left winding of overflow relay 523, left contact of cam 527, resistance 530 to ground. Relays 522 and 318 operate in this circuit, relay 318 locking over its upper front contact, the lower right contact of cam 710, thence over the circuit traced whereby it remains energized as the sequence switch 700 advances into position 4. Relay 318 also closes a circuit to advance sequence switch 700 into position 4 extending from battery through the winding of magnet 700, lower right contact of cam 712, lower front contact of relay 318, thence as previously traced to ground at the left contact of cam 703.

The district selector is now controlled by the sender in its brush and group selection movements and then proceeds to hunt for an idle trunk in the wellknown manner. When the district sequence switch reaches position $4\frac{3}{4}$ after the completion of brush selection, the circuit previously traced from the contact of relay 547 and extending to the upper right contact of cam 709 is extended over the lower

left contact of cam 709, conductor 611 to ground through the left windings of zone relays 610 and 609. Relay 609 and relay 610 operate and lock over their right windings and inner right front contacts, conductor 612 to ground at the lower left contact of cam 707. After an idle trunk is selected a circuit is established in position 9 of sequence switch 700 for relay 318 extending from battery through the lower winding of this relay, upper left contact of cam 718, upper right contact of cam 719, lower right and upper left contacts of cam 704, front contact of relay 351 to ground at the upper right contact of cam 720. Relay 318 upon operating advances sequence switch 700 into position 10 over a circuit extending from ground on the lower front contact of relay 318, lower right contact of cam 712 to battery through the winding of magnet 700. In position 10 relay 318 remains energized over the circuit previously traced. In position 10, which is the selection beyond position of the district selector sequence switch, the control of succeeding switches is effected over a fundamental circuit which may be traced in part from brush 721, the upper right and lower left contacts of cam 722, conductor 723, the lower back contact of relay 321, conductor 378, thence as traced to the sender through the windings of relays 522 and 523, cam 546, brush 544 and compensating resistance 545, the back contact of relay 524, the right front contact of relay 507, conductor 543, terminal 489 and brush 488, the right contacts of cam 405, brush 406, terminal 407, conductor 379, the upper left and lower right contacts of cam 724 to brush 725.

As soon as the selections are completed and the connection has been set up to the called subscriber's line 800, reversed battery from the incoming selector 801 operates relays 522 and 523 in the usual manner. These relays, in turn, cause the operation of relay 531 and relays 524 and 504. With these relays operated the sender sequence switch is advanced to position 18 for controlling talking selection. Relay 351 is operated in parallel with the winding of relay 316 throughout selections. The operation of relay 504 above mentioned now opens a shunt around the right winding of relay 503 including that winding in the circuit of relays 351 and 316. Relay 351 thereupon releases, in turn, opening the circuit of relay 318, which also releases. Upon the release of relay 318 the district sequence switch 700 is advanced into position 11 over a circuit extending from battery, winding of magnet 700, right contacts of cam 726, lower back contact of relay 318, to ground as traced at the lower left contact of cam 703. As the sequence switch enters position 11, ground is connected to conductor 320 at the lower left contact of cam 720 over terminal 433, brush 432, upper contacts of cam 446, left winding of relay 415, right back

contact of relay 409, lower contact of cam 434, brush 431, terminal 430, conductor 506, left back contact of relay 505, windings of relay 503. Since these windings are also connected to ground relay 503 now releases, in turn releasing relay 507. The release of relay 507 does not release relay 509, since that relay is locked to its own front contact. A circuit is therefore closed from ground over the left back contact of relay 507, front contact of relay 509 to the winding of relay 505, which relay locks over its middle left contact to conductor 506 and to ground as above traced. After leaving position 10 relays 351 and 316 are both disconnected from conductor 320. Sequence switch 700 is then advanced into position 12 over a circuit extending from battery through magnet 700, the lower right contact of cam 712, the left contacts of cam 708 to ground at the right contact of cam 707. In passing into position 12 the subscriber's line becomes disconnected from the sender at contacts of cams 715 and 717.

Talking selection

With sequence switch 700 in position 12 relay 318 is energized in a circuit extending to the sender from battery through its upper winding, the lower left contact of cam 710, the lower left contact of cam 711, conductor 378, terminal 401, brush 402, upper contacts of cam 435, brush 436, terminal 437, conductor 532, the front contact of relay 521, the front contact of relay 504, the right contact of cam 526, the sender sequence switch being in position 18 for talking selection, the windings of relays 522 and 523, the right contact of cam 527, the right back contact of relay 507 to ground through resistance 530. Relays 318 and 522 energize in this circuit, relay 318 closing a circuit extending from battery through sequence switch magnet 700, the lower right contact of cam 712, the lower front contact of relay 318, conductor 319, right contacts of cam 607, to ground at the lower right contact of cam 703. Relay 318 upon energizing locks to the fundamental circuit over its upper winding and outer upper front contact and the lower right contact of cam 710. As sequence switch 700 rotates out of position 12 toward position 16, ground is intermittently connected to the fundamental circuit in shunt of sender stepping relay 522 at the upper right and lower left contacts of cam 706. When the sender is satisfied as to its talking selection setting, the fundamental circuit is opened at the sender through the operation of relay 525 and relay 318 deenergizes arresting the sequence switch 700 in its next stopping position. The sequence switch may be arrested in any one of three positions, position 13 which is a charging position for connections to zones, 0, 2, and 4, position 14 which is a

charging position for connections to zones 1, 3 and 5 and position 15 for connections to an operator's position. Since it has been assumed that the calling subscriber has made a call into zone 5 for the exchange, the district sequence switch will be arrested in talking selection position 14.

At the sender after talking selection is completed relay 515 operates connecting battery to conductor 506 in parallel with the winding of relay 505. The current in this circuit is now sufficient to operate relay 415 which closes a circuit from battery through the left winding of relay 417, lower contacts of cam 421 to ground at the left front contact of relay 415. Relay 417 closes a circuit from battery through the winding of sequence switch magnet 400, upper contact of cam 479, outer right front contact of relay 417, left back contact of relay 409 to ground, advancing sequence switch 400 to position 6. In this position all of the conductors extending to the sender are opened and the sender is completely released. As soon as sequence switch 400 leaves position 5, relay 415 releases and, in turn, releases relay 417, unless the sender finder 420 is standing on one of its top ten terminals. If the latter condition exists relay 417 is held operated in a circuit from battery over its left winding, left front contact, upper contact of cam 424, commutator segment 464, brush 463 to ground. With relay 417 operated at this time a circuit is closed from battery through resistance 411, winding of relay 409, upper right and lower left contacts of cam 414, inner right front contact of relay 417, right contact of cam 416 to ground. Relay 409 locks through its inner left contacts to ground at the upper contact of cam 467 and also closes a second locking circuit for relay 417. With relay 409 operated a circuit is closed from battery through the winding of down drive magnet 465 of the sender finder 420, left contact of cam 412 to ground at the outer left front contact of relay 409. When the sender finder reaches its lowermost position a circuit is closed from ground over brush 463, bottom commutator segment 406, upper contact of cam 456 to resistance 411, shunting the winding of relay 409 and causing that relay to release and, in turn, release relay 417. With relay 417 released in position 6, a circuit is closed from battery through the winding of sequence switch magnet 400, lower right contact of cam 476, right back contact of relay 417 to ground at the right contact of cam 416, advancing sequence switch 400 to position 7.

When sequence switch 400 reaches position 7, the link circuit is ready to associate itself with another district selector. If another district selector is standing in position 1 waiting association with a link, a circuit will be closed from ground over the lower left contact of cam 720 of that district selector,

lower right contact of cam 713, upper right contact of cam 714, contact 727 of jack 728, conductor 392, contact of jack 448, contact of jack 449, upper left contact of cam 416, right back contact of relay 415, lower right and upper left contacts of cam 414, winding of relay 413 to battery. Relay 413 closes a circuit from battery through the left winding of relay 417, left front contact of relay 413 to ground at the left back contact of relay 415. Relay 417 in operating closes a circuit for updrive magnet 447 of the district finder 410, lower right contact of cam 479, right front contact of relay 417, left back contact of relay 409 to ground. The district selector finder moves upwardly under control of magnet 447 in search of the district selector which is awaiting a link. Such a district selector is identified by battery connected over the lower contacts of cam 729 of that district selector, contacts 730 of jack 728 to conductor 366. Relay 413, in operating, closes the same circuit through the right and middle windings of relay 415 as it closed in position 2. At this time the test circuit extends from ground at the left front contact of relay 413 through the middle winding of relay 415, lower left and upper right contacts of cam 421, left winding of relay 415, right back contact of relay 409, lower right and upper left contacts of relay 419, contact of jack 449 to brush 451.

If the district selector for which the district selector finder is hunting does not lie between the last position occupied by the finder and the top of its bank, it will continue to move upwardly until brush 453 engages segment 452 completing a circuit over the upper right contact of cam 408, winding of relay 409, resistance 411 to battery. The operation of relay 409 opens the test circuit, opens the circuit of updrive magnet 447 and closes a circuit from battery through the winding of downdrive magnet 454, lower right contact of cam 412, left front contact of relay 409 to ground. The district selector finder is restored to its lowermost position under the control of magnet 454 at which time a circuit is closed from ground over brush 453, bottom segment 455 of the district selector finder commutator, lower right contact of cam 456 to resistance 411, shunting and releasing relay 409 which restores the test circuit and the circuit of updrive magnet 447. When brush 451 encounters terminal 450 to which conductor 366 extends, the test circuit is completed and relay 415 operates quickly as in the previous case. Relay 415 locks through its right winding, the left contacts of cam 421 to ground at its left front contact opening the circuit of relay 417 to deenergize magnet 447 and bring the district selector finder to rest on the terminals of the district selector. With relay 415 operated and relay 417 released, a circuit

is closed from battery through the winding of sequence switch magnet 400, upper left contact of cam 476, contact 427 of jack 428, back contact of relay 413, right front contact of relay 415, upper left contact of cam 416, contacts of jacks 449 and 448 to conductor 392. Sequence switch 400 advances to position 8 in this circuit.

Relay 415 is held operated in position 8 from battery at the district selector over terminal 450, brush 451, contacts of jack 449, upper left and lower right contacts of cam 419, back contact of relay 409, left winding of relay 415, upper right and lower left contacts of cam 421 to ground at the left front contact of relay 415. With relay 415 operated a circuit is closed from ground at the right contact of cam 416, right front contact of relay 415, upper left contact of cam 429, brush 478, terminal 477, conductor 375, upper right contact of cam 711, lower left contact of cam 710, upper winding of relay 318 to battery. Relay 318 operates and closes a circuit from battery through the winding of sequence switch magnet 700, lower right contact of cam 712, lower front contact of relay 318, thence as traced to ground at the lower left contact of cam 703. Sequence switch 700 advances to position 2, releasing relay 318. The advance to position 2 removes ground from conductor 392 and battery from conductor 366. The removal of battery from conductor 366 opens the circuit of relay 415 and that relay releases, closing a circuit from battery through the winding of sequence switch magnet 400, lower left contact of relay 476, right back contact of relay 415 to ground at the right contact of cam 416. Sequence switch 400 advances to position 9.

The link circuit remains in this position until the link standing next to it in the series is advanced from position 1 for the purpose of selecting a sender. Link circuit 260 occupying that relationship to the link circuit of Fig. 4, a circuit may be traced from ground over the lower contact of cam 261, upper left contact of cam 262, conductor 263, contact 460 of jack 428, upper right contact of cam 461, lower right contact of cam 462, winding of sequence switch magnet 400 to battery, advancing the link circuit sequence switch to position 10 which is the equivalent of position 1 so that the link circuit is ready to operate in response to the next call in the group of lines served thereby.

Returning to the operation of the district selector in the establishment of the connection, as soon as the sequence switch 700 advances into the talking position 14 a circuit is established for supplying the calling subscriber with talking current, which circuit may be traced from battery through the lower left winding of repeating coil 731, right contact of cam 717, winding of relay 716, inner

lower back contact of relay 316, brush 331 and terminal 332, conductor 116 over the subscriber's line, conductor 117, terminal 333 and brush 334, upper back contact of relay 316, upper right contact of cam 715 to ground through the upper left winding of coil 731. Relay 716 energizes in this circuit closing a circuit for relay 351 extending from battery, winding of relay 351, resistance 732, contact of relay 716 to ground over the lower left contact of cam 720.

Making initial charge for a call into zone 5 of the exchange area

It will be recalled that for a call into zone 5 of the exchange area the district sequence switch 700 was arrested in talking selection position 14 and that both zone relays 609 and 610 have been operated and locked. When the called subscriber 800 responds after the application of ringing current to his line from the incoming selector 801 in the well known manner, relay 301 operates in a circuit which may be traced in part from brush 721 over the upper contacts of cam 722, the upper right winding of repeating coil 721, the lower right and upper left contacts of cam 733, the winding of polarized relay 301, the lower right winding of coil 731, the lower contacts of cam 724 to brush 725. Upon operating, relay 301 establishes a circuit extending from battery through the winding of relay 302, the lower contact of interrupter 322, as soon as the interrupter advances, conductor 323, the lower contact of cam 613, conductor 614, the lower contacts of cam 718, conductor 734, the front contact of relay 301 to ground at the upper left contact of cam 703. Relay 302 then locks over its lower front contact, conductor 324, the upper right and lower left contacts of cam 615, conductor 616, the lower right contact of cam 719, the lower right contact of cam 718, conductor 734, front contact of relay 301, thence to ground as previously traced. When the upper contact of interrupter 322 closes a circuit is established from ground at the upper left contact of cam 703 thence as traced to interrupter 322, over the upper front contact of relay 302, the right contacts of cam 702, the lower contacts of cam 705, conductor 735, the lower left contact of cam 617 to battery through the winding of sequence switch magnet 600 for advancing this sequence switch into position 2.

With sequence switch 600 in position 2 a circuit is established extending from battery through the winding of relay 321, conductor 325, upper left contact of cam 613, conductor 614, the lower left contact of cam 718, the lower right contact of cam 719, conductor 616 to ground over the left contacts of cam 615. Relay 321, upon operating, locks over its inner upper front contact to ground at the lower right contact of cam

703. When sequence switch 600 leaves position 1, the holding circuit of relay 302 is opened at the contacts of cam 615 and relay 302 releases. Switch 600 is advanced through positions 2 to 6 into position 7 under the control of interrupter 618 in the following manner: When sequence switch 600 reaches position 2 a circuit is established from ground over the upper contact of cam 619, the lower contact of interrupter 618, upper right and lower left contacts of cam 620, right back contact of relay 621, conductor 312, winding of relay 305, conductor 311, lower contacts of cam 603, conductor 622 to battery. Relay 305 operates and prepares a holding circuit for itself extending from battery over the circuit previously traced, through the winding of relay 305, conductor 312, the lower contact of cam 604, the winding of relay 621, conductor 313, the front contact of relay 305 to ground over the line finder commutator segment 306 and brush 307. Relay 621 does not operate in this circuit until the interrupter 618 opens its lower contact. When relay 621 operates a circuit is established from battery through resistance 623, lower right contact of cam 624, lower right contact of cam 625, conductor 626, lower contacts of cam 705, conductor 735, the lower contacts of cam 627, the right front contact of relay 621, conductor 310 to brush 381, terminal 380, conductor 114, back contact of line relay 101 to ground through the calling subscriber's message register 105. The message register is thus operated once to register a charge. Relay 621 at its right back contact also opens the circuit previously traced to the lower contact of interrupter 618.

As soon thereafter as interrupter 618 closes its upper contact a circuit is established from ground at the upper contact of cam 619, upper contact of interrupter 618, inner left front contact of relay 621 to battery through the winding of sequence switch magnet 600 for advancing the sequence switch to position 3. When the sequence switch leaves position 2, relays 305 and 621 release, their holding circuit being opened at the lower left contact of cam 603. Relay 621, upon releasing, opens the circuit of sequence switch magnet 600 to arrest the sequence switch in position 3. In position 3, previously traced circuits are established under the control of the lower contact of interrupter 618 for reoperating relays 305 and 621. With sequence switch 600 in position 3 and relay 621 operated the circuit of message register 105 is again established from battery, through resistance 623, the lower right contact of cam 624, the upper contact of cam 629, the left contact of cam 607, conductor 608, upper back contact of relay 302, conductor 300, upper contact of cam 601, inner left front contact of relay 610, which it will be recalled was operated from the

sender, right contacts of cam 627, right front contact of relay 621, conductor 310 and thence as traced to ground through the message register magnet 105. The message register is thus operated a second time.

As soon thereafter as interrupter 618 closes its upper contact the previously traced circuit is closed for advancing sequence switch 600 to position 4, whereupon relays 305 and 621 again release. In position 4 the previously traced circuits are established under the control of the lower contact of interrupter 618 for reoperating relays 305 and 621. With sequence switch 600 in position 4 and relay 621 operated, the circuit of message registry 105 is again established from battery, through resistance 623, the lower right and upper left contacts of cam 624, thence as previously traced through the inner left front contact of relay 610 to ground through the message register magnet 105. The message register is thus operated a third time.

When the interrupter 618 again closes its upper contact the sequence switch 600 is advanced to position 5, as previously described, whereupon relays 305 and 621 again release. In position 5 the previously traced circuits are established under the control of the lower contact of interrupter 618 for reoperating relays 305 and 621. With sequence switch 600 in position 5 and relay 621 operated the circuit of message register 105 is again established from battery, through resistance 623, the lower right contact of cam 624, the lower left contact of cam 629, the left front contact of zone relay 609, the upper left contact of cam 607, conductor 608, upper back contact of relay 302, conductor 300, upper contact of cam 601, inner left front contact of relay 610, right contacts of cam 627, right front contact of relay 621, conductor 310 and thence as traced to ground through the message register magnet 105. The message register is thus operated a fourth time.

When the interrupter 618 again closes its upper contact the sequence switch 600 is advanced to position 6, as previously described, whereupon relays 305 and 621 again release. In position 6 the previously traced circuits are established under the control of the lower contact of interrupter 618 for reoperating relays 305 and 621. With sequence switch 600 in position 6 and relay 621 operated, the same circuit for message register 105 is closed as was closed with sequence switch 600 in position 5 and the message register is operated a fifth time. When the interrupter 618 again closes its upper contact, the sequence switch 600 is advanced into position 7 and relays 305 and 621 again release.

Making initial charge for calls into other zones of the exchange area

In the preceding description it has been assumed that the call was for a subscriber's line

terminating in zone 5 of the exchange area. At this point the description of the progress of such a call will be arrested to describe how calls to other zones of the exchange area are charged for. It will be recalled that in the operation of the sender, relay 536 operated alone for calls to certain zones, relay 547 operated alone for calls to other zones and that neither of these relays operated for calls to other zones and that with relay 536 operated the zone relay 610 of the register control circuit was operated and locked, that with relay 547 operated both zone relays 609 and 610 operated and locked and that with neither relay 536 or 547 operated neither zone relay 609 or 610 operated. Further, it will be recalled that for calls to zones 0, 2 and 4, the district sequence switch 700 was set into talking position 13 and that for calls to zones 1, 3 and 5, sequence switch 700 was set into position 14.

If, therefore, a local call is made terminating in zone 0 for which no charge should be made neither of zone relays 609 and 610 will be operated and sequence switch 700 will be set into talking position 13. Under this condition sequence switch 600 will not advance out of position 1 as the circuit previously traced for advancing it will be opened at the lower right contact of cam 705. In this case, relay 321 is operated following the operation of relay 302 over a circuit extending from battery, through its winding, conductor 325, the left back contact of relay 610, conductor 638, the left contacts of cam 705, the right contacts of cam 702, the upper front contact of relay 302, the upper contact of interrupter 322, conductor 323, the lower contact of cam 613, conductor 614, the lower contacts of cam 718, conductor 734, the front contact of relay 301 to ground at the upper left contact of cam 703. A locking circuit for relay 302 is now established through the winding of relay 302 and its lower front contact, the upper front contact of relay 321 to ground at the upper left contact of cam 720. Since sequence switch 600 is not advanced out of position 1, the message register 105 will not be operated.

Had the subscriber made a call into zone 1 neither of the zone relays 609 or 610 would be operated and sequence switch 700 would be positioned in talking selection position 14. In charging position 2 of sequence switch 600, the circuit previously traced for operating the message register 105 would be closed at the lower contacts of cam 705. However, as the sequence switch 600 passed through charging positions 3 to 6, inclusive, due to the unoperated condition of zone relays 609 and 610 no operating circuits for the message register 105 would be closed and therefore the message register would be operated but once.

Had the subscriber made a call into zone 2, zone relay 610 would have operated and sequence switch 700 would have been set into position 13. When, therefore, sequence

switch 600 passed through charging position 2, the circuit for operating the message register would not have been closed since the lower right contact of cam 705 would be opened. In passing charging positions 3 and 4 the circuits previously traced extending through the inner left front contact of zone relay 610 would be closed but the circuits previously traced in positions 5 and 6 of sequence switch 600 would be opened at the left contact of zone relay 609. Thus, for calls to zone 2 the message register 105 would be operated but twice.

Had the subscriber made a call in the zone 3, zone relay 610 would have operated and sequence switch 700 would have been set in position 14. When, therefore, sequence switch 600 passed through positions 2, 3 and 4, the previously traced circuits for operating the message register would have been established, but the circuits traced in positions 5 and 6 of sequence switch 600 would have been opened at the left contact of zone relay 609. Thus, for calls to zone 3 the message register 105 would be operated three times.

If a call had been made into zone 4, both zone relays 609 and 610 would have been operated and sequence switch 700 set into position 13. When therefore sequence switch 600 passed through charging positions 2 to 6 the circuits previously traced in connection with a call into zone 5 would have been established with the exception of the circuit established in position 2 of sequence switch 600 which will be opened at the lower right contact of cam 705. The message register 105 would thus be operated four times for calls to zone 4.

Timing the initial period of conversation for calls to zone 5

Returning to the consideration of the call which it was assumed, the calling subscriber had made to subscriber's line 800 terminating in zone 5, it will be recalled that following the registration of the call, the sequence switch 600 advanced into position 7 and relays 305 and 621 released. With sequence switch 600 in position 7 a circuit is closed from the office timing circuit 630 over the left contacts of cam 620, the right back contact of relay 621, conductor 312, winding of relay 305, conductor 311, the lower contacts of cam 603, conductor 622 to battery, operating relay 305. Relay 305 locks as previously described in series with relay 621, relay 621 operating in the locking circuit of relay 305 as soon as ground is removed at the timing circuit 630. Relay 621 upon operating closes a circuit from battery through the winding of sequence switch magnet 600, inner left contact of relay 621, lower left contact of cam 631 to ground at the lower left contact of cam 632, thus advancing the sequence switch 600 out of position 7. Upon leaving position

7 the holding circuit of relays 621 and 305 is opened at the lower left contact of cam 603, and these relays release, relay 621 opening the circuit of magnet 600 to arrest the sequence switch in position 8. Sequence switch 600 is thus advanced from position to position into position 18 at 30 second intervals under the control of timing circuit 630, measuring off ten complete intervals or a maximum of 5 minutes for the initial period of conversation.

As sequence switch 600 passes through position 16 a circuit is closed for relay 302 extending from battery, winding of relay 302, lower contact of interrupter 322, conductor 323, the lower contact of cam 613, conductor 614, the lower left contact of cam 718, the lower right contact of cam 719, conductor 616, the lower left and upper right contacts of cam 615, conductor 324, the upper front contact of relay 321 to ground at the upper left contact of cam 720. Relay 302, upon operating locks over its lower front contact to ground over the upper front contact of relay 321 independent of interrupter 322 and of sequence switch 600. With sequence switch 600 in position 18 a check is made to determine if conversation is still in progress. If the calling and called subscribers have not disconnected, relays 301 and 716 will be operated and a circuit will be established for relay 621 extending from battery over conductor 622, left contacts of cam 603, resistance 606, winding of relay 621, the right contact of cam 613, conductor 614, the lower contacts of cam 718, conductor 734, the front contact of relay 301 to ground at the upper left contact of cam 703. Relay 621, upon operating, establishes a circuit for advancing sequence switch 600 into position 1 which may be traced from battery, winding of magnet 600, the upper left contact of cam 628, the outer left front contact of relay 621, conductor 633, the middle upper front contact of relay 302, conductor 634 patched to the outer front contact of relay 610, armature of relay 610 patched to conductor 636, or over conductor 634 patched over conductor 639 to conductor 636, the lower right contact of cam 631, the lower right contact of cam 632, the outer left front contact of relay 621, conductor 637, the front contact of relay 716 to ground at the lower left contact of cam 720. With sequence switch 600 in position 1 relay 621 releases.

As soon thereafter as interrupter 322 closes its upper contact a circuit is established for advancing sequence switch 600 into position 2 which may be traced from battery, winding of magnet 600, lower left contacts of cam 617, conductor 735, the lower contacts of cam 705, the right contacts of cam 702, the upper front contact of relay 302, the upper contact of interrupter 322, conductor 323, the lower contact of cam 613, conductor

614, the lower contacts of cam 718, conductor 734, the front contact of relay 301 to ground at the upper left contact of cam 703. In position 2 of sequence switch 600 the charging circuit is again established for message register 105 under the control of relays 305 and 621, as previously described, and sequence switch 600 is advanced to position 3 releasing relays 305 and 621. With sequence switch 600 in position 3 a circuit is established for advancing it to position 7 extending from battery through the winding of magnet 600, the upper right contact of cam 617, the outer right front contact of relay 610, conductor 634, middle upper front contact of relay 302, conductor 633, upper right contact of cam 631 to ground at the lower left contact of cam 632. In position 7 a circuit is established for advancing sequence switch 600 into position 8 extending from battery, winding of magnet 600, lower right contact of cam 617, conductor 633, middle upper front contact of relay 302, conductor 634, outer right front contact of relay 610, conductor 636, lower right contact of cam 631 to ground at the lower left contact of cam 632. From position 8 sequence switch 600 is driven directly into position 12, over a circuit extending from battery through the winding of magnet 600, lower right contact of cam 617, conductor 633, middle upper front contact of relay 302, conductor 634, the outer right front contact of relay 610, upper right contact of cam 624, lower left contact of cam 625, inner left front contact of relay 610, upper right contact of cam 635 to ground at the lower left contact of cam 632. From position 12 sequence switch 600 is advanced into position 14 over a circuit which extends as previously traced from battery through the winding of magnet 600 to the upper right contact of cam 624, thence over the lower left contact of cam 625, inner left front contact of relay 610, upper right and lower left contacts of cam 627, conductor 735, lower contacts of cam 705, conductor 626, lower contact of cam 635 to ground at the lower left contact of cam 632. From position 14 sequence switch 600 is advanced to position 16 over the circuit previously traced to the upper left contact of cam 625, thence over the left front contact of relay 609, the upper left contact of cam 635 to ground at the lower left contact of cam 632.

With sequence switch 600 in position 16 a circuit is established for relay 305 from ground at the office timing circuit 630, over the left contacts of cam 620, the right back contact of relay 621, conductor 312, winding of relay 305, conductor 311, the lower contacts of cam 603, conductor 622 to battery operating relay 305. Relay 305 locks as previously described in series with relay 621, relay 621 operating in the locking circuit of relay 305 as soon as ground is removed at the timing circuit 630. Relay 621, upon operating, closes

a circuit from battery through the winding of sequence switch magnet 600, inner left contact of relay 621, lower left contact of cam 631, lower left contact of cam 632 to ground, thus advancing sequence switch 600 to position 17. Upon reaching position 17, the holding circuit or relays 621 and 305 is opened at the lower left contact of cam 603 and these relays release, relay 621 opening the circuit of magnet 600 to arrest the sequence switch in position 17. In the same manner sequence switch 60 is advanced into position 18. The sequence switch in advancing from positions 16 to 18 under the control of the timing circuit 630 has measured two thirty second intervals or a full minute for the overtime period for conversation.

In position 18 a check is again made to determine if the conversation is still continuing and if so switch 600 is advanced in another revolution to charge and measure time in the manner just described for an additional minute of conversation. Additional overtime periods for conversation are measured and charged in this manner until disconnection occurs.

Charging and timing overtime periods for calls to zones 0 to 4 inclusive

For calls to the local zone 0 it will be recalled that since sequence switch 700 is set into position 13 the sequence switch 600 is not advanced out of position 1 and, therefore, no timing or charging is made for either the initial period of conversation or for the overtime periods. For calls to zone 1 with sequence switch 700 in position 14 and zone relays 609 and 610 both non-operated, if no charging for overtime periods is to be made, conductor 634 will be connected to the outer right front contact of zone relay 610 and conductor 636 will be connected to the outer right armature of relay 610. When, therefore, the check is made in position 18 of sequence switch 600 at the end of the initial period of conversation to determine if the subscribers are still conversing, the circuit previously traced will be closed and relay 621 will operate. Since, however, zone relay 610 is not operated for a call to zone 1 the previously traced circuit from battery through sequence switch magnet 600, left contact of cam 628, outer left front contact of relay 621, conductor 633, middle upper front contact of relay 302, conductor 634, front contact of relay 610, conductor 636, the lower right contact of cam 631, the lower right contact of cam 632, conductor 637, the front contact of relay 716 to ground at the lower left contact of cam 720, will be open at the front contact of relay 610 and sequence switch 600 will remain in position 18 until disconnection takes place, and no charge will be registered for the overtime periods of conversation.

If the traffic requirements are such that a charge should be made for each overtime period on all calls to zone 1 then conductor 634 will be connected over conductor 639 to conductor 636, rather than through front contacts of relay 610 and the previously traced circuit for advancing sequence switch 600 into position 1 will be established. From position 1 sequence switch 600 is advanced into position 2 in the manner previously described for a call to zone 5 causing a single operation of the message register 105, following which sequence switch 600 advances into position 3. From position 3, sequence switch 600 is advanced into position 7 over a circuit extending from battery, winding of magnet 600, upper right contact of cam 617, right back contact of relay 610 to ground over the left contacts of cam 632. Sequence switch 600 is then advanced into position 8 over a circuit extending from battery through the winding of magnet 600, lower right contact of cam 617, conductor 633, middle upper front contact of relay 302, conductor 634, conductor 639, conductor 636, lower right contact of cam 631 to ground at the lower left contact of cam 632. In position 8 a circuit is established from battery over conductor 622, the lower contacts of cam 603, conductor 311, winding of relay 305, conductor 312, right back contact of relay 621, left contacts of cam 620 to ground at the office timing circuit 630. Relay 305 operates in this circuit locking as previously described through the winding of relay 621. Relay 621 operates in this locking circuit as soon as ground is removed at the timing circuit 630, closing a circuit from battery, winding of magnet 600, inner left front contact of relay 621, lower left contacts of cams 631 and 632 to ground. Sequence switch 600 thereupon advances into position 9, releasing relays 621 and 305. In position 9 relays 621 and 305 again operate, advancing sequence switch 600 into position 10. In this manner, sequence switch 600 advances from position to position into position 18, measuring an overtime period of five minutes. In position 18 a check is again made to determine if the conversation still continues and if so, sequence switch 600 is advanced into position 1 and thence through a further cycle in the manner just described.

For calls to zone 2 with sequence switch 700 is in position 13 and the zone relay 610 operated, when the check is made in position 18 of sequence switch 600 to determine if the subscribers are still conversing at the end of the initial period of conversation the circuit previously traced for advancing sequence switch into position 1 for starting an overtime charging and timing cycle, is closed and sequence switch 600 will be advanced to position 8 in the manner previously described in connection with calls into

zone 1, causing a single operation of the message register 105 as it passes through position 2. From position 8 sequence switch 600 is advanced directly into position 12 over a circuit extending from battery, winding of magnet 600, lower right contact of cam 617, conductor 633, middle upper front contact of relay 302, conductor 634, conductor 639, conductor 636, upper right contact of cam 624, lower left contact of cam 625, inner left front contact of relay 610, right contact of cam 635 to ground at the lower left contact of cam 632. There is no direct circuit for advancing sequence switch 600 out of positions 12 and 13 as previously described in connection with a call to zone 5 as this circuit is open at the lower right contact of cam 705, sequence switch 700 being in position 13, and there is no direct circuit for advancing sequence switch 600 out of position 14 into position 16 as previously described in connection with the call to zone 5 as such circuit is open at the left front contact of relay 609. Sequence switch 600 is, therefore, advanced from position 12 into position 18 under the control of timing circuit 630 to measure off an overtime period of three minutes. Additional overtime periods are measured in the same manner.

For calls to zone 3 with sequence switch 700 in position 14 and zone relay 610 operated, sequence switch 600 is advanced from position 18 of its first cycle into position 12 of a second cycle in the manner previously described for calls to zone 2 operating the message register 105 once as it passes through position 2. From position 12 sequence switch 600 is advanced to position 14 over the circuit previously traced over the lower contacts of cam 705 and from position 14 it is advanced into position 18 under the control of the office timing circuit 630 to measure off an overtime period of two minutes. Additional overtime periods are measured in the same manner.

For calls to zone 4 with sequence switch 700 in position 13 and both zone relays 609 and 610 operated, sequence switch 600 is advanced from position 18 of its first cycle into position 12 of a second cycle in the manner previously described for calls to zone 5, operating the message register 105 once as it passes through position 2. Since sequence switch 700 is in position 13 there is no direct path for advancing sequence switch 600 out of position 12 and, therefore, this sequence switch advances into position 14 under the control of the office timing circuit 630, measuring off an overtime period of one minute. From position 14 sequence switch 600 is advanced directly into position 16 over the circuit previously traced through the left front contact of relay 609 and from position 16 into position 18 under the control of the office timing circuit 630, thus measuring off an addi-

tional overtime period of one minute. Thus, for calls to zone 4 a total of two minutes is measured for each overtime period.

From the foregoing discussion the charging and time measuring functions of the circuits for calls to various zones of the exchange area may be recapitulated as indicated in the following table:

Zone	Time limit for initial period	Number of charges for initial period	Time limit for overtime periods	Number of charges for overtime periods
0.....	No limit.....	None.....	No limit.....	None.....
1.....	5 minutes.....	1.....	5 minutes.....	1 or more
2.....	5 minutes.....	2.....	3 minutes.....	1
3.....	5 minutes.....	3.....	2 minutes.....	1
4.....	5 minutes.....	4.....	2 minutes.....	1
5.....	5 minutes.....	5.....	1 minute.....	1

It will be noted from the foregoing description that the number of charges made both for initial and overtime periods and the time interval allowed for both initial and overtime periods is under the control of the zone relays 609 and 610 and the sequence switch 700 in either position 13 or position 14. Thus, by altering the connections from the contacts of cams of sequence switch 600 to contacts of zone relays 609 and 610 and to circuits extending through contacts of sequence switch 700, the manner in which the connections are timed and charges made therefor for calls to different zones, may be altered as required to satisfy traffic regulations imposed by the operating company in the exchange in which these circuits may be employed.

Release of connection

When the calling subscriber hangs up to terminate the call, relay 716 releases in turn releasing relay 351, thereby establishing a circuit for relay 316 which may be traced from battery through the upper winding of relay 316, left contacts of cam 714, upper back contact of relay 351 to ground at interrupter 328. Relay 316 upon operating disconnects the line finder brushes 334, 331, 326 and 381 thereby releasing the cut-off relay 102, locks over its lower winding and lower front contact, conductor 612 to ground at the lower left contact of cam 707, at its upper front contact short-circuits and releases relay 621 if it is at the time operated, and establishes a circuit for advancing sequence switch 600 out of position 2 if it is at the time in position 2, extending from ground at its inner upper front contact, conductor 329, left contact of cam 640 to battery through the winding of magnet 600, or if sequence switch 600 is in any other position than 2, for advancing sequence switch 700 out of either position 13 or 14 into position 17. This latter circuit may be traced from ground at the inner upper front contact of relay 316 over conductor 329, left contact of cam 640, con-

ductor 330, upper contacts of cam 701, the upper right contact of cam 712 to battery through the winding of sequence switch magnet 700. As soon as sequence switch 700 leaves position 14, if sequence switch 600 is not in normal position it is advanced into normal position over a circuit extending from battery, winding of magnet 600, right contacts of cam 641, conductor 602 to ground at the lower left contact of cam 703. When sequence switch 700 leaves position 13 or 14 the locking circuit of relay 302 is opened and relay 302 releases.

As sequence switch 700 passes into position 16 a circuit is closed from battery through the winding of relay 351, resistance 732, right contacts of cam 704, upper contacts of cam 719, commutator segment 335 and brush 336 to ground. Relay 351 operates but releases when sequence switch 700 reaches position 17. In position 17 relay 302 operates in a circuit through its winding, lower right and upper left contacts of cam 714, back contact of relay 351 to ground at interrupter 328 and closes a circuit from battery, winding of magnet 700, the lower left contact of cam 712, the upper front contact of relay 302, conductor 300, the lower left contact of cam 601, conductor 602 to ground at the lower left contact of cam 703, advancing sequence switch 700 into position 18. Upon leaving position 17 relay 302 remains locked over its lower front contact, the upper contacts of cam 719 to ground over commutator segment 335 and brush 336 and relay 321 releases. A circuit is now closed for the down drive magnet 337 of the line finder extending from battery through the winding of magnet 337, the lower left and upper right contacts of cam 702, the upper front contact of relay 302, thence as traced to ground at the lower left contact of cam 703. When the line finder reaches normal position ground is removed from commutator segment 335, thereby releasing relay 302 and arresting the line finder switch shaft in normal position. In position 18 of sequence switch 700 a circuit is also established from battery through the down drive magnet 736 of the district selector, right contacts of cam 710, upper right and lower left contacts of cam 706 to ground for driving the district selector shaft into normal position, in which position a circuit is established from battery through the winding of sequence switch magnet 700, upper right contact of cam 712, normal commutator segment 737 and brush 738 to ground at the right contact of cam 707 for advancing sequence switch 700 into normal position. Upon leaving position 16 1/4 ground is removed at the lower contacts of cam 706 from test brush 739 thereby initiating the release of succeeding selector switches. All apparatus employed in the connection is now in normal condition.

Prevention of false charging and timing

In order to guard against false charging and timing due to trouble crosses on relay and sequence switch cam contacts and trouble grounds in the charging and timing switch of Fig. 6 and in the district sequence switch of Fig. 7, safeguards have been incorporated in the circuits which serve only to prevent excessive charging or undertiming of any period of conversation when a trouble condition occurs. Although a large number of these safeguards have been incorporated in the circuits, it is believed that it will be sufficient to describe herein only a few of the safeguards which are most typical.

It will first be assumed that zone relay 610 sticks in its operated condition. It will be recalled that zone relay 610 operates on calls to zones 2 to 5, inclusive, and when operated more than one charge will be made for the initial period of any call. Should a call be made for zone 1 with relay 610 incorrectly operated, the calling subscriber will thus be overcharged since for calls to zone 1 only one charge should be made. To avoid this condition when the district sequence switch 700 is in position 2 and the line finder is hunting for the calling line with the sequence switch 600 in position 1, a circuit is established from ground over the left contacts of cam 706, conductor 605, the inner left contact of relay 610, the lower left contact of cam 625, the lower left contact of cam 624, thence over the lower contacts of cam 704, the lower front contact and winding of relay 302 to battery, locking relay 302. Relay 302, therefore, cannot release although relay 305 operates to open its regular locking circuit when the calling line is found and thus the circuit of the up-drive magnet is maintained to drive the line finder to the telltale position without establishing a connection with the calling line. The line finder is thus put out of service.

It will be recalled that upon disconnection when the calling subscriber hangs up, relay 716 releases, in turn, releasing relay 351. Relay 351, upon releasing, establishes a circuit over its upper back contact for relay 316 as soon as interrupter 328 closes. Should there be a cross however on the lower contacts of relay 351, relay 351 would be held operated from ground at the interrupter 328 over the lower contacts of relay 351, the upper contacts of cam 704, resistance 732 to battery through the winding of relay 351 and the disconnection would not be recognized and therefore sequence switch 600 would be advanced, if the called subscriber has not hung up, into an overtime cycle and the calling subscriber would be charged for overtime periods until the called subscriber hangs up even though he has disconnected.

To obviate such a false operation when the sequence switch 700 is in position 2 and the line finder is trunk hunting, relay 302 will be locked up over its lower front contact, the lower right and upper left contacts of cam 704, the crossed contacts of relay 351 to ground at the upper right contact of cam 720, thereby causing the line finder to be driven to the telltale position without establishing a connection with the calling line.

Suppose, for example, that a trouble ground should occur on conductor 602. When sequence switch 600 has completed charging as previously described in position 2 and is advanced by the operation of relay 621 into position 3, a circuit would be established from the trouble ground over the right contacts of cam 641 to battery through the winding of magnet 600, advancing it at once into position 1 and thence again in position 2, as previously described, where a further charge would be made. In this manner the calling subscriber would be charged at about one second intervals until he disconnects. To obviate this possibility a circuit is provided over the lower left contact of cam 641 in positions 1 and 2, conductor 642, the inner lower front contact of relay 321, conductor 643, the lower contacts of cam 620, the right back contact of relay 621, the lower contact of cam 604, winding of relay 621, conductor 313, front contact of relay 305 to ground over commutator segment 306 and brush 307, thus shunting the winding of relay 621 to prevent it from operating in the locking circuit of relay 305. Since relay 621 does not operate, no charging path is closed in position 2 of sequence switch 600 and therefore as sequence switch 600 repeatedly rotates from position 2 into its normal position due to the trouble ground, no charges are registered.

As another typical example of trouble that might arise, it will be assumed that the upper right and lower left contacts of cam 635 become crossed accidentally. It will be recalled that in measuring an overtime period for calls to zone 2, sequence switch 600 is advanced directly into position 12 and is then timed into position 18, under the control of the office timing circuit 630 to measure a conversational period of three minutes. If now the contacts of cam 635 are crossed, as above assumed, sequence switch 600 will also be driven from position 12 into position 14 without being subject to the control of the timing circuit, over the same circuit that advanced it from position 8 into position 12 and therefore the calling subscriber would be given one less minute for each overtime period than he would be entitled to for a call to zone 2. To obviate this undertiming condition, when sequence switch 600 reaches position 17 during the initial period of conversation, a cir-

cuit is established from ground at the right contact of cam 707, the upper left and lower right contacts of cam 708, closed in positions 13 and 14, conductor 338, the right contact of cam 601, conductor 300, the upper front contact of relay 302, the right contacts of cam 702, conductor 626, the lower and upper right contacts of cam 635, assumed to be crossed, the inner left front contact of relay 619 which is operated for calls to zone 2, the lower left contact of cam 625, the right contact of cam 629, conductor 311, winding of relay 305, conductor 312, the right back contact of relay 621. the left contacts of cam 620 to ground at the office timing circuit 630. Relay 305 is thus shunted and cannot operate and in consequence relay 621 does not operate to advance sequence switch 600 out of position 17. Sequence switch 600 therefore remains in position 17 for the remainder of the call and no charges are made for overtime.

From the foregoing it will be apparent that in accordance with the present invention calls may be charged in accordance not only with the zone into which they have been extended, but also charged differently for initial and overtime periods of conversation in accordance with the several zones and that the calling subscriber is safeguarded from being overcharged for any call either through the excessive operation of his message register or through the undertiming of the periods allotted to him for conversation.

What is claimed is:

1. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means to variably operate said charging device, time controlled means for thereafter further advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means for changing the control of said timing switch over said charging device on all cycles subsequent to the initial cycle.

2. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said

calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means to variably operate said charging device, time controlled means for thereafter advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means for changing the speed of advance of said timing switch on all cycles subsequent to the initial cycle whereby a conversational period different from the initial period is measured for all overtime periods of conversation.

3. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means to variably operate said charging device, time controlled means for thereafter advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch advancing through similar cycles to repeatedly operate said charging device until said connection is released, and means cooperative with said recording means for changing the speed of advance of said timing switch on all cycles subsequent to the initial cycle whereby a conversational period different from the initial period is measured for all overtime periods of conversation in accordance with the zone of the exchange in which the called line terminates.

4. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in such advance in accordance with the condition of said recording means to variably operate said

charging device, time controlled means for thereafter advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means cooperative with said recording means for changing the control of said timing switch over said charging device and for changing the speed of advance of said timing switch on all cycles subsequent to the initial cycle.

5. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of the timing switch in accordance with the condition of said recording means to variably operate said charging device, time-controlled means for thereafter further advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch to normal if neither the calling or called subscriber has disconnected, and means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released.

6. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means to variably operate said charging device, time-controlled means for thereafter further advancing said timing switch to measure off an initial period for conversation, means for thereafter advancing said timing switch to normal if neither the calling nor called subscribers have disconnected, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means for changing the speed of advance of said timing switch on all cycles subsequent to the initial cycle whereby a conversational period different from the initial

period is measured for all overtime periods of conversation.

7. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, means for selectively controlling said switches, means associated with one of said switches for altering circuits thereof in accordance with the zone in which a called line terminates, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a call has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means and in accordance with the setting of said altering means to variably operate said charging device, time-controlled means for thereafter further advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means for changing the control of said timing switch over said charging device for all cycles subsequent to the initial cycle.

8. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, means for selectively controlling said switches, means associated with one of said switches for altering circuits thereof in accordance with the zone called, a charging device for said calling line, a timing switch, zone recording relays associated with said timing switch, means in said switch controlling means for selectively operating said relays, means operative upon the response of the called subscriber to advance said timing switch, a plurality of operating paths for said charging device adapted to be closed by said timing switch during its advance, and means controlled jointly through the setting of said altering means and said recording relays for selectively rendering said paths effective.

9. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling lines to said called lines, means for selectively controlling said switches, means associated with one of said switches for altering circuits thereof in accordance with the zone called, a charging device for said calling line, a timing switch, zone recording relays associated with said timing switch, means in said switch controlling means for selectively operating

said relays, means operative upon the response of the called subscriber to advance said timing switch, a plurality of operating paths for said charging device adapted to be closed by said timing switch during its advance, means controlled jointly by said altering means and said recording relays for selectively rendering said paths effective, time controlled means for thereafter further advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means controlled jointly by said altering means and said recording relays for changing the number of effective charging device operating paths and the speed of advance of said timing device on all cycles subsequent to the initial cycle.

10. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means to variably operate said charging device, time controlled means for thereafter further advancing said timing switch to measure off a predetermined conversational period, a relay operable when said timing switch approaches the end of its cycle, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means controlled jointly by said relay and said recording means for changing the speed of advance of said timing switch on all cycles subsequent to the initial cycle.

11. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, means for selectively controlling said switches, means associated with one of said switches for altering circuits thereof in accordance with whether the number of the zone is of odd or even value, a charging device for said calling line, a timing switch, zone recording relays associated with said timing switch, means in said switch controlling means for selectively operating said relays in accordance with whether the zone called is the local or first, second or third, etc., means operative upon the response of the called subscriber to advance said timing switch, a plurality of operating paths for

said charging device adapted to be closed by said timing switch during its advance, and means controlled jointly through the setting of said altering means and said recording relays for selectively rendering said paths effective.

12. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, means for selectively controlling said switches, means associated with one of said switches for altering circuits thereof in accordance with whether the number of the zone called is of odd or even value, a charging device for said calling line, a timing switch, zone recording relays associated with said timing switch, means in said switch controlling means for selectively operating said relays in accordance with whether the zone called is the local or first, second or third, etc., means operative upon the response of the called subscriber to advance said timing switch, a plurality of operating paths for said charging device adapted to be closed by said timing switch during its advance, means controlled jointly through the setting of said altering means and said recording relays for selectively rendering said paths effective, time controlled means for thereafter further advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means for changing the number of effective operating paths on all cycles subsequent to the initial cycle.

13. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, means associated with one of said switches for altering circuits thereof in accordance with the zone called, a charging device for said calling line, a timing switch, zone recording relays associated with said timing switch, means in said switch controlling means for selectively operating said relays, means operable upon the response of the called subscriber to advance said timing switch, a plurality of operating paths for said charging device adapted to be closed by said timing switch during its advance, means controlled jointly by said altering means and said recording relays for selectively rendering said paths effective, time controlled means for thereafter further advancing said timing switch to measure off a predetermined conversational period, a transfer relay operable when said timing switch approaches the end of its cycle, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means

controlled jointly by said recording relays, said altering means and said transfer relay for changing the number of effective paths and the speed of advance of said timing switch on all cycles subsequent to the initial cycle.

14. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in said advance to operate said charging device, time controlled means for thereafter advancing said timing switch to measure off a predetermined period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means to prevent the excessive operation of said charging device and the undertiming of conversational periods due to unstandard conditions arising in said timing switch.

15. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in said advance to operate said charging device, time controlled means for thereafter advancing said timing switch to measure off a predetermined period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means to prevent the excessive operation of said charging device due to unstandard conditions arising in said timing switch.

16. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in said advance to operate said charging device, time controlled means for thereafter advancing said timing switch to measure off a predetermined period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until said connection is released, and means to prevent the excessive operation of said charging device through the undertiming of conversational periods due to un-

standard conditions arising in said timing switch.

17. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling lines, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means to variably operate said charging device, and means operative if said recording means is normally in an unstandard condition for preventing the extension of a connection from the calling line.

18. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the condition of said recording means to variably operate said charging device, means for thereafter further advancing said timing switch to measure off a predetermined conversational period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until the connection is released, and means for rendering the timing switch ineffective to operate said charging device if an unstandard condition exists in the circuits of said timing switch which would cause the calling subscriber to be overcharged.

19. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending the calling line to said called lines, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with said recording means to variably operate said charging device, means for thereafter further advancing said timing switch to measure off a predetermined conversa-

tional period, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until the connection is released, means cooperative with said recording means for changing the speed of advance of said timing switch on all cycles subsequent to the initial cycle whereby a conversational period different from the initial period is measured off for overtime periods of conversation in accordance with the zone of the exchange in which the called line terminates, and means for preventing the advance of said timing switch on overtime cycles if an unstandard condition exists which would cause under-timing of calls to certain zones.

20. In a telephone exchange system, a calling line, a plurality of called lines terminating in different zones of the exchange, selector switches for extending a connection from the calling line to said called lines, subscriber controlled means for releasing said connection, a charging device for said calling line, a timing switch, means associated with said timing switch for recording the zone of the exchange into which a connection has been extended, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled in the advance of said timing switch in accordance with the setting of said recording means to variably operate said charging device, means to thereafter further advance said timing switch to measure off a predetermined period for conversation, means for thereafter advancing said timing switch through similar cycles to repeatedly operate said charging device until the connection is released, and means operative if said releasing means is defective for preventing the extension of a connection from said calling line.

In witness whereof, I hereunto subscribe my name this 24th day of June, 1930.

RAYMOND E. COLLIS.