Dec. 25, 1928. 1,696,271

A. E. HAGUE

CALL CHARGING TELEPHONE EXCHANGE SYSTEM

Filed Oct. 26, 1927 7 Sheets-Sheet 1

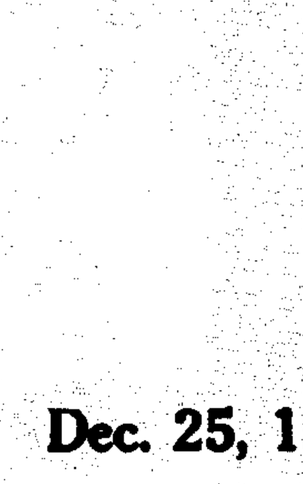

FIG. 8.

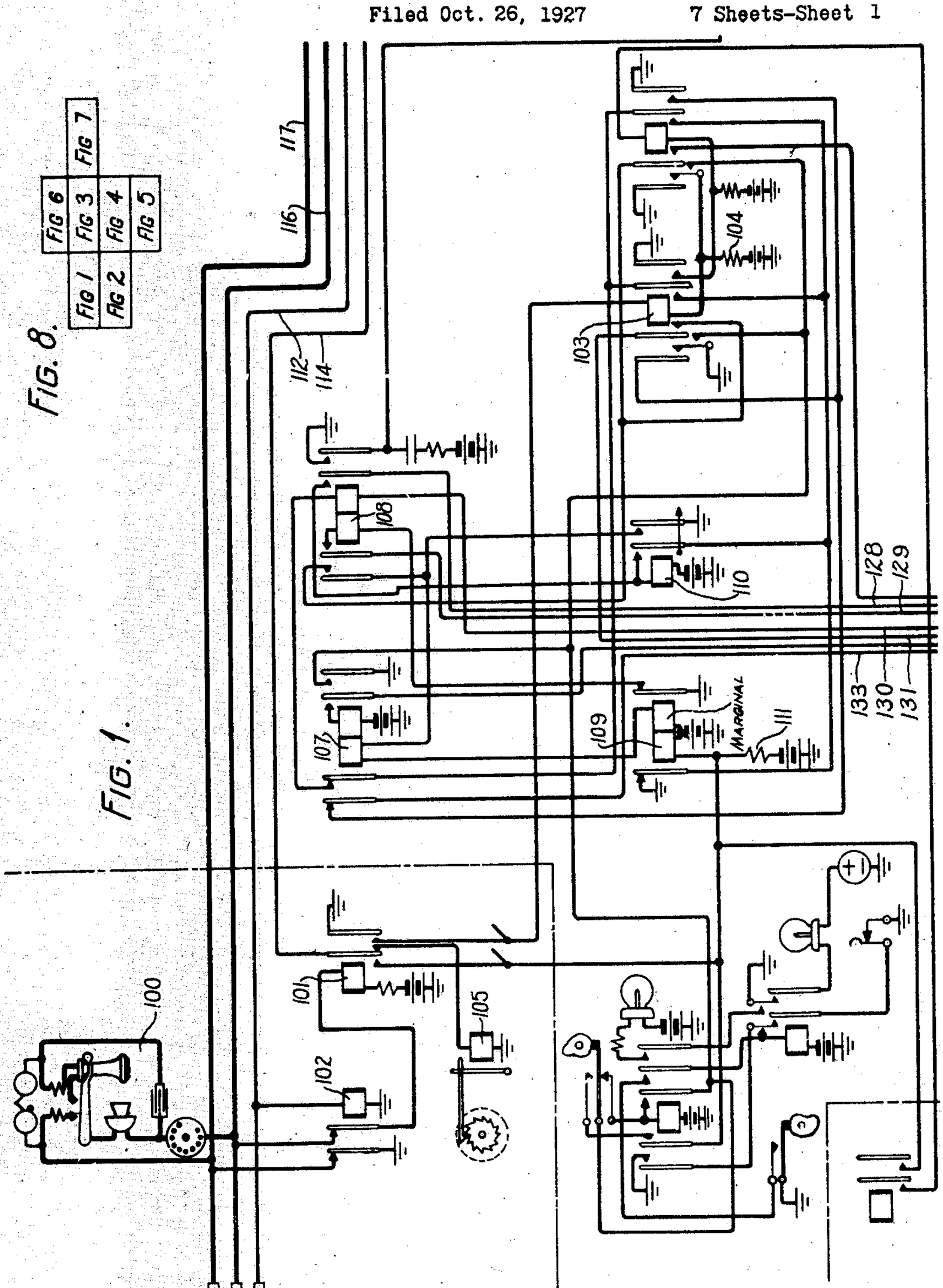

FIG. 1.

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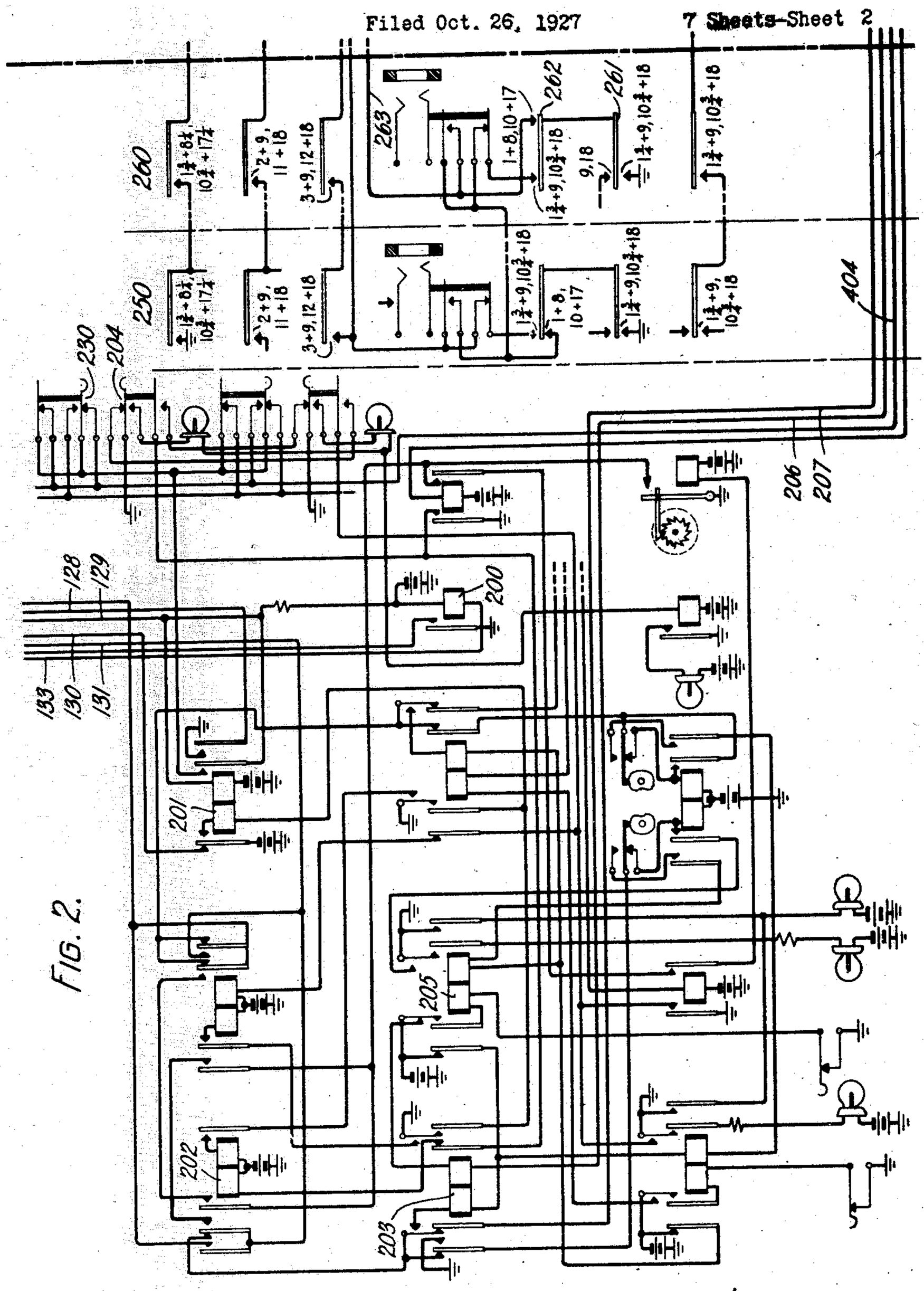

FIG. 2.

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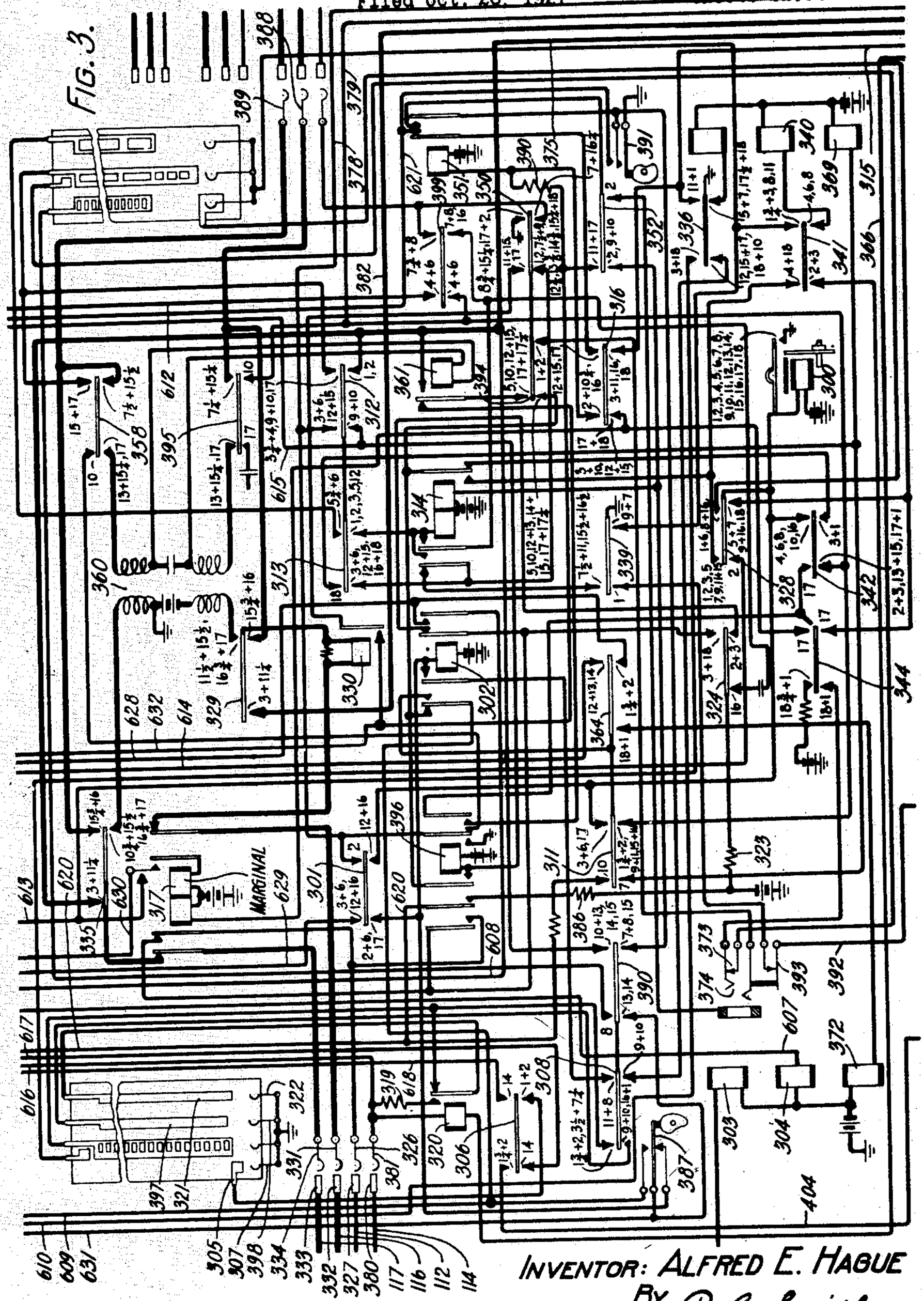
FIG. 3.



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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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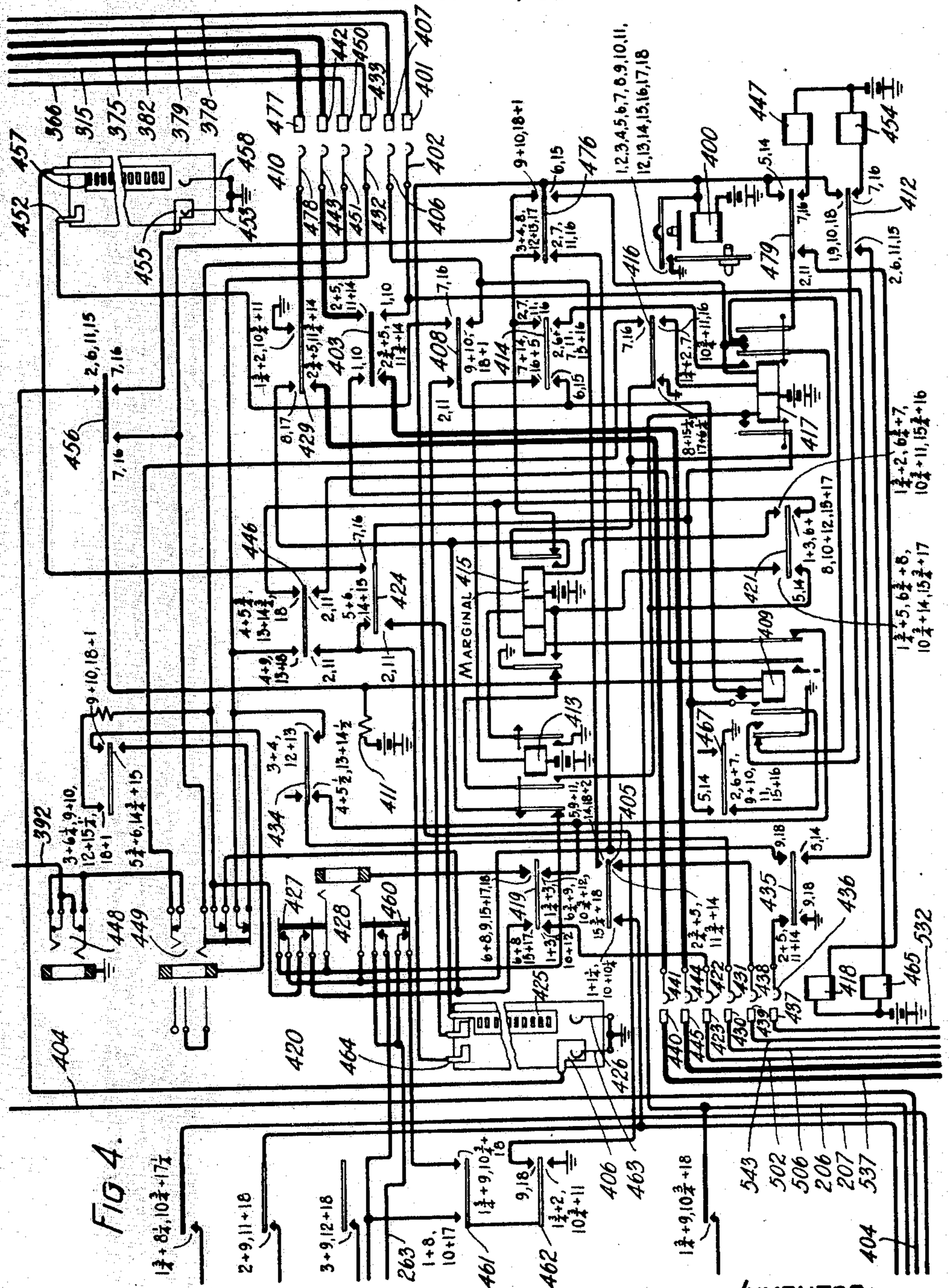

FIG 4.

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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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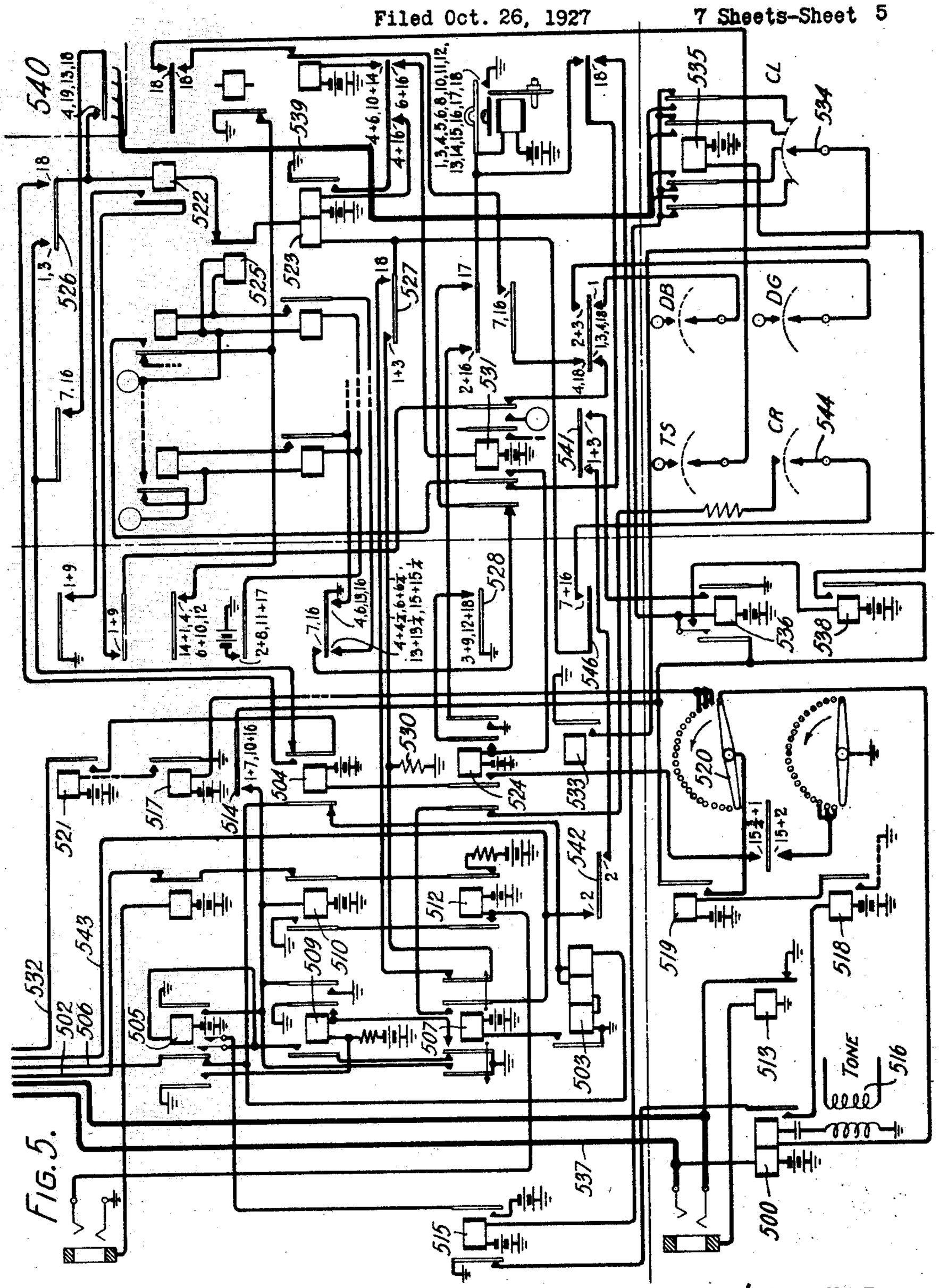

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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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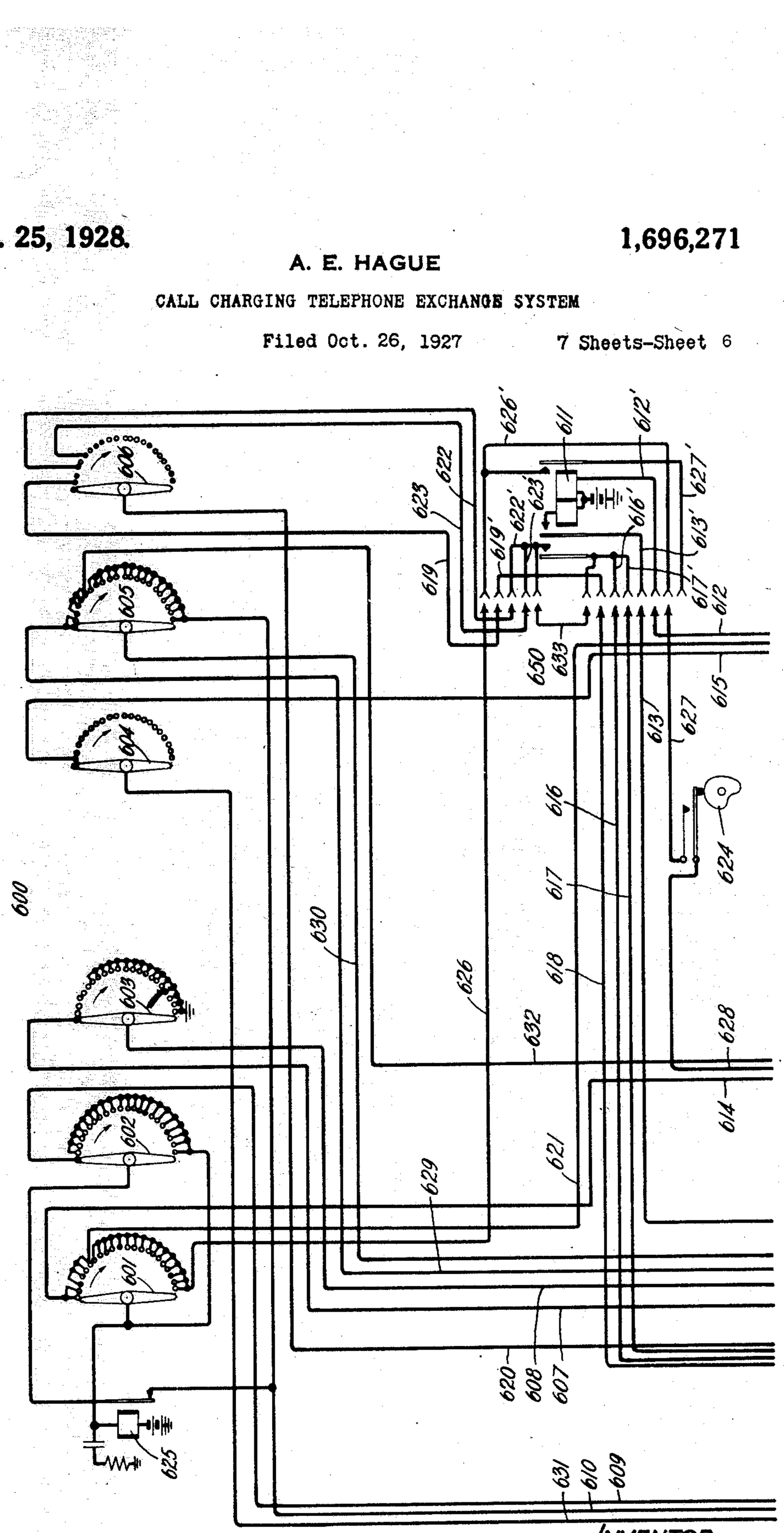
FIG. 6.



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CALL CHARGING TELEPHONE EXCHANGE SYSTEM

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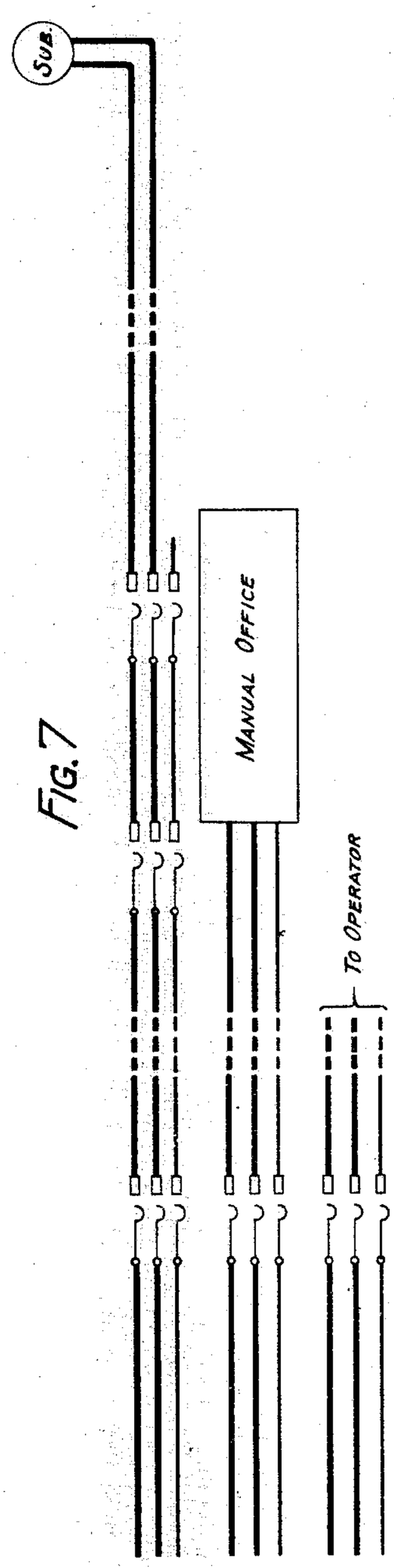
FIG. 7



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UNITED STATES PATENT OFFICE.

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CALL-CHARGING TELEPHONE-EXCHANGE SYSTEM.

Application filed October 26, 1927. Serial No. 228,715.

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 which will charge the calling subscriber in such a manner as to more equitably recompense the operating telephone company for the use of exchange equipment.

In large exchange areas having several offices some of which may be located at vary 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 remotely located offices must be reached over long interoffice trunks which are expensive to install and maintain and it is not equitable to the company to provide service to all points in the exchange area at the same basic rate.

Of course, 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 connection or to cause the proper operation of the subscriber's message register. However, where connections are established entirely by machine 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 telephone company that for a basic charge the subscriber shall be enabled to hold an established connection indefinitely. In manual systems, of course, 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 machine switching device, operator supervision is not desirable and from a standpoint of economy the supervision of elapsed time 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 has heretofore been accomplished. In accordance with the present invention, however, one specific embodiment of which is disclosed herein by way of example, this is accomplished in the following improved manner: A timing switch is provided which is started upon the response of the called subscriber and, under the control of a timing interrupter completes its cycle once during each unit period of 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 intial portion of its cycle, transmits impulses to the calling subscriber's message register, the number of register operations depending upon the zone of exchange into which the calling subscriber has dialed. The timing switch continues to advance through successive cycles as long as the conversation lasts, transmitting registering impulses during each cycle. The number of registering impulses which the timing switch sends for each unit period is controlled by the sequence switch of the district selector with which the charge controlling equipment is associated and by the sender, the sequence switch assuming different positions dependent on the zone into which the call is extended by the district selector. Upon the termination of the call the timing switch is arrested as soon as it again reaches normal and the connection is dismissed. Registration is thus effected during the conversation in accordance with the elapsed time for the conversation and in accordance with the zone of the exchange into which the call was extended.

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 for preventing interference between calling lines;

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

Fig. 3 shows a line finder and district selector;

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

Fig. 5 shows a portion of a register sender;

Fig. 6 shows a message register controlling circuit associated with the district selector of Fig. 3;

Fig. 7 shows in schematic form selectors for completing a connection to an automatic subscriber, to a manual office or to an operator; and

Fig. 8 shows the manner in which Figs. 1 to 6 should be arranged.

The invention has been embodied in a disclosure which is substantially like that of U. S. Patent 1,567,072 to W. H. Matthies, granted December 29, 1925. Both the present disclosure and that of the Matthies patent show 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 in the case of the above mentioned patents a plurality of link circuits are 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.

It will be assumed that the subscriber at sub-station 100 first initiates a call for which he is to be charged three times for each 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 line relay 101, inner 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 through resistance 104, winding of relay 103 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 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, inner right contact of relay 103, to ground at the left contact of relay 109.

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 to ground at the right contact of relay 109. 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 to ground at the left back contact of relay 109. Relay 110 closes a circuit for starting the allotted line finder.

Assuming that the link and line finders shown are the ones to be used next, sequence switch 400 will be standing in position 1 and sequence switch 300 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, upper right and lower left contacts of cam 301, winding of relay 302, to battery.

Relay 302 in operating closes a circuit from battery through the winding of up-drive magnet 304 of the line finder, conductor 607, brush 603 and normal terminal of timing switch 600, conductor 608, right front contact of relay 302, lower right contact of cam 364, outer left front contact of relay 302, conductor 609, normal terminal and brush 602, interrupter contacts of stepping magnet 625, conductor 610 to ground at the lower left contact of cam 336. The line finder moves upward under the control of magnet 304 and, since trip magnet 303 is operated, the proper set of brushes is tripped. As soon as the line finder moves upward, a locking circuit is provided for relay 302 extending over its inner left front contact, upper contacts of cam 308, right back contact of relay 320, commutator strip 321, brush 322 to ground, which holds relay 302 operated independent of the start circuit. As soon as commutator brush 307 engages segment 305, a circuit is closed from ground over brush 307 and segment 305, lower right and upper left contacts of cam 306, 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 307 leaves segment 305, 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 to conductor 114 and therefore to battery, a circuit is completed from this battery through the winding of relay 320, lower left and upper right contacts of cam 341, to ground at the lower right contact of cam 339. Relay 320 operates in this circuit and closes a shunt around its winding through resistance 319, to ground over commutator strip 321 and brush 322. This reduces the resistance in series with the winding of marginal relay 109 sufficiently to cause that relay to operate and open the locking circuit of relay 110, which in turn opens the energizing circuit of relay 302. The operation of relay 320 also opens the locking circuit of relay 302, causing that relay to release. The release of relay 302 closes a circuit from ground through the winding of cut-off relay 102, conductor 112, terminal 327, brush 326, back contact of relay 317, right back contact of relay 302, lower right contact of cam 324, resistance 323 to battery. The operation of cut-off relay 102 opens the circuit of line relay 101, removing battery from conductor 114, releasing relays 109 and 320.

At the time relay 302 operated, it closed a circuit from ground at the lower left contact of cam 336, conductor 610, contacts of magnet 625, brush 602, conductor 609, outer left front contact of relay 302, lower right contact of cam 311, 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 sequence switch 400 leaves position 1, relay 409 is released. In position 2, a circuit is closed from battery through the winding of relay 413, upper contacts of cam 414, right back contact of relay 415, to ground at the left contact of cam 416. Relay 413 operates, closing 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 from battery through the winding of up-drive 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 upward 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, upper contacts of cam 421, middle winding of relay 415, to ground at the right contact of relay 413. The current in this circuit, however, is not sufficient to operate relay 415 but does create a flux in the windings of that relay so that it becomes quick to operate when the test circuit is 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, lower right and upper left contacts of cam 421, middle winding of relay 415, to ground at the right 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. The relay 415 in operating closes a locking circuit for itself from battery through the right winding of relay 415, upper 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 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, lower 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 left contact of cam 416, advancing sequence switch 400 to position 3.

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 relays 504 and 505, conductor 506, terminal 430, brush 431, right contact of cam 434, brush 432 and terminal 433, conductor 315, contacts of cam 316 (assuming that the district selector has been advanced to position 3 as hereinafter described) through the left winding of relay 317 and the winding of relay 351 in parallel to battery. Relay 317 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 2¾ 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, left contact of cam 335, left back contact of relay 317, brush 334, terminal 333, conductor 117 through the subscriber's substation, conductor 116, terminal 332, brush 331, right back contact of

relay 317, winding of relay 330, left contact of cam 329, 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, register steering switch 520 in its normal position, front contact of relay 519, lower contact of cam 514 to ground at the front contact of relay 509. This tone is transmitted to the calling subscribed to inform him that the sender is ready to receive impulses which he may then send out by manipulating his dial.

When relay 510 operated it removed battery from conductor 502, releasing relay 415. With relay 415 released, a circuit is closed from battery through the winding of sequence switch magnet 400, upper left contact of cam 476, right back contact of relay 415 to ground at the lower left 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.

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 the dialing of the first digit the register steering switch, one wiper of which is shown at 520, advances from normal, closing a circuit for relay 517, extending from battery through the winding of relay 517, terminals and brush 520, contacts of relay 519, contact of cam 514 to ground at the outer right contact 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 the manner described in the aforementioned patent to O. H. Kopp. When the translator assumes its setting relay 533 operates, closing a circuit over the translator arc 534 through a back contact of relay 535, if the subscriber has dialed the number of a subscriber located in a zone of the exchange for which an additional charge must be made on the calling subscriber's message register, thence through the winding of relay 536 to battery. Relay 536 energizes and locks over its left front contact, the contact of cam 514 to ground at the outer right front contact of relay 509 and extends locking ground through its left front contact to the winding of relay 538, causing the operation of the latter relay. Relay 538 upon operating establishes a circuit from ground at the outer right contact of relay 509, 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 536 and connecting the translator arc 534 over the 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. Relay 536 upon energizing prepares a circuit extending from ground over its right contact, the contacts of cams 541 and 542 being closed during the brush selection controlling 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 lower left contact of cam 399. This circuit is completed as will be described hereinafter through the winding of relay 611 of the registration controlling circuit for indicating at the registration controlling circuit the fact that the subscriber has initiated the establishment of a connection into a zone of the exchange area for which he should be assessed an additional charge.

When the link circuit advances into position 2 for hunting for an idle sender, a circuit is closed for relay 314, extending from battery through the left winding of relay 314, lower right contact of cam 313, lower right contact of cam 312, conductor 375, terminal 477, and brush 478 of district finder 410 to ground at the right contact of cam 429. When relay 302 releases and relay 314 energizes, a circuit is closed for advancing sequence switch 300 into position 3, extending from battery through magnet 300, the upper left contact of cam 328, the right front contact of relay 314, the left back contact of relay 302, conductor 609, brush 602, interrupter contacts of magnet 625, conductor 610 to ground at the lower left contact of cam 336. As the sequence switch 300 advances from position 2 to 3, relay 314 releases.

With sequence switch 300 in position 3 relay 314 is again energized over a circuit extending from battery through its left winding, the lower right contact of cam 313, the upper left contact of cam 312, conductor 378, terminal 401 and brush 402 of district finder 410, the lower right and upper left contacts of cam 435, brush 436 and terminal 437 of sender finder 420, the front contact of relay 521, the back contact of relay 504, the left contact of cam 526, winding of sender stepping relay 522, winding of overflow relay 523, left contact of cam 527, resistance 530 to ground. Relays 522 and 314 operate in this circuit, relay 314 locking over its outer left front contact and the lower left contact of cam 313, thence over the circuit traced, whereby it remains energized as the sequence switch 300 advances into position 4. Relay 314 also closes a circuit to advance sequence switch 300 into position 4, extending from battery

through magnet 300, upper left contact of cam 328, right front contact of relay 314, thence as previously traced to ground at the upper left contact of cam 336.

When the district sequence switch reaches position 4 for controlling brush selection, the circuit previously traced from the contact of relay 436 and extending to the lower left contact of cam 399 is extended over the left contacts of cam 399, conductor 612, patched to conductor 612′, to battery through the right winding of relay 611. Relay 611 upon energizing locks over its left winding and left front contact, conductor 613, patched to conductor 613′ to ground at the upper left contact of cam 336.

The district selector is now controlled by the sender in its brush and group selections and then proceeds to hunt for an idle trunk in the well known manner. After an idle trunk is selected, a circuit is established in position 9 of the sequence switch 300 for relay 314, extending from battery through the right winding of this relay, the lower left contact of relay 352, the front contact of relay 351, the lower contacts of cam 308, commutator segment 397, brush 398, advancing the sequence switch 300 into position 10. In position 10 relay 314 remains energized over the circuit just traced. In position 10 which is the selection beyond position of the district circuit the control of succeeding switches is effected over a fundamental circuit which may be traced in part from brush 389, through the lower right and upper left contacts of cam 358, the right back contact of charging relay 396, conductor 378, thence as traced to the sender through the windings of relays 522 and 523, cam 546, brush 544, compensating resistance 545, left back contact of relay 524, right front contact of relay 507, conductor 543, returning over terminal 439 and brush 438, the right contacts of cam 405, brush 406, and terminal 407, conductor 379, the right contacts of cam 395, to brush 388.

As soon as selections are completed and the connection has been set up to the called subscriber's line, reversed battery from the incoming selector 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 is advanced to position 18 for controlling talking selection. Relay 351 is operated in parallel with the winding of relay 317 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 317. Relay 351 thereupon releases, in turn opening the circuit of relay 314, which also releases. Upon the release of relay 314 the district sequence switch 300 is advanced into position 11 over a circuit extending from battery, winding of magnet 300, right contacts of cam 342, right back contact of relay 314, outer left back contact of relay 302 to ground as traced at the lower left contact of cam 336. As the sequence switch enters position 11, ground is connected to conductor 315 at the upper right contact of cam 336, which is extended over terminal 433, brush 432, upper contacts of cam 446, left winding of relay 415, right back contact of relay 409, left contact of cam 434, brush 431, terminal 430, conductor 506, left back contact of relay 505 to the 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 317 are both disconnected from conductor 315. Sequence switch 300 is then advanced into position 12 over a circuit extending from battery through magnet 300, the upper left contact of cam 328, the upper contacts of cam 341, to ground at the right contact of cam 339. In passing into position 12 the subscriber's line becomes disconnected from the sender at contacts of cams 329 and 335.

Talking selection.

With sequence switch 300 in position 12, relay 314 is energized in a circuit extending to the sender from battery through its left winding, the lower right contact of cam 313, the upper left contact of cam 312, conductor 378, terminal 401, brush 402, the lower right and upper left 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 to ground through resistance 530. Relays 314 and 522 energize in this circuit, relay 314 closing a circuit extending from battery through sequence switch magnet 300, the upper left contact of cam 328, the outer right front contact of relay 314, the lower left contact of cam 394 to ground at the upper right contact of cam 350. Relay 314 upon energizing locks to the fundamental circuit over its left winding and outer left front contact and lower left contact of cam 313. As sequence switch 300 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 lower left contact of cam 350. 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 314 deenergizes, arresting sequence

switch 300 in its next stopping position. The sequence switch may be arrested in any one of three positions; position 13 which may be a no-charge position, position 14 which is a charging position for connections to certain zones of the exchange, and position 15 for connections to an operator's position.

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, left 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 is true, relay 417 is held operated in a circuit from battery over its left winding, left front contact, upper left 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, lower contacts of cam 414, inner right front contact of relay 417, lower left contact of cam 416 to ground. Relay 409 locks through its inner left contacts to ground at the lower 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 lower left 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. If another district is standing in position 1 waiting association with a link, a circuit will be closed from ground over the lower left contact of cam 339 of that district, contact 393 of jack 374 conductor 392, contact of jack 448, contact of jack 449, upper contact of cam 416, right back contact of relay 415, upper 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 up-drive 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 finder moves upward under control of magnet 447 in search of the district which is awaiting a link. Such a district is identified by battery connected over the left contacts of cam 344 of that district, contact 373 of jack 374, 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 right front contact of relay 413, through the middle winding of relay 415, upper left and lower right contacts of cam 421, left winding of relay 415, right back contact of relay 409, lower right and upper left contacts of cam 419, contact of jack 449 to brush 451.

If the district for which the district 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 upward 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 up-drive magnet 447 and closes a circuit from battery through the winding of down-drive magnet 454, lower right contact of cam 412, left front contact of relay 409 to ground. The district 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 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 up-drive 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 upper 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 finder to rest on the terminals of the district. With relay 415 operated and relay 417 released, a circuit is closed from battery through the winding of sequence switch magnet 400, lower left contact of cam 476, contact 427 of jack 428, back contact of relay 413, right front contact of relay 415, upper right 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 over terminal 450, brush 451, contact of jack 449, upper left and lower right contacts of cam 419, back contact of relay 409, left winding of relay 415, lower right and upper 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 left contact of cam 416, right front contact of relay 415, upper left contact of cam 429, brush 478, terminal 477, conductor 375, lower right contact of cam 312, lower right contact of cam 313, left winding of relay 314 to battery. Relay 314 operates and closes a circuit from battery through the winding of sequence switch 300, upper left contact of cam 328, right front contact of relay 314, outer left back contact of relay 302, thence as traced to ground at the lower left contact of cam 336. Sequence switch 300 advances to position 2 in this circuit, releasing relay 314. 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, upper left contact of cam 476, right back contact of relay 415, to ground at the lower left contact of cam 416. Sequence switch 400 advances to position 9.

The link circuit remains in this position until the link circuit 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 right contact of cam 262, conductor 263, contact 460 of jack 428, upper right contacts of cams 461 and 462, winding of sequence switch magnet 400 to battery, advancing the link circuit 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.

As soon as the sequence switch 300 advances into the talking position 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 360, upper right contact of cam 329, winding of relay 330, right back contact of relay 317, brush 331 and terminal 332, conductor 116, over the subscriber's line, conductor 117, terminal 333 and brush 334, outer left back contact of relay 317, lower contact of cam 335 to ground, through the upper left winding of coil 360. Relay 330 energizes in this circuit closing a circuit for relay 351 extending from battery, winding of relay 351, resistance 390, contact of relay 330 to ground over the upper contacts of cam 350. Relay 350 energizes but performs no useful function at this time.

Charging for a call to a remote zone of exchange area.

It has been assumed that the calling subscriber has initiated a call to a remote zone of the exchange requiring three operations of the message register 105 for each unit period of conversation. For this call therefore the district sequence switch 300 has been set into position 14. With sequence switch 300 in position 14, when the called subscriber responds a circuit is completed for relay 361 extending from the tip brush 389, over the lower contacts of cam 358, upper right winding of repeating coil 360, winding of relay 361, lower right winding of coil 360, upper contacts of cam 395 to brush 388. Relay 361 energizes and a circuit is established for relay 302 as soon as interrupter 387 closes its lower contact, from battery, winding of relay 302, lower contact of interrupter 387, lower left and upper right contacts of cam 390, front contact of relay 361, upper contact of cam 394 to ground at the upper right contact of cam 350. Upon the energization of relay 302 a circuit is closed to advance the timing switch 600 off normal as soon as the interrupter 387 closes its upper contact, which circuit may be traced from battery, winding of stepping magnet 625, brush 601 and its normal terminal, conductor 614, upper right contact of cam 364, outer left front contact of relay 302, upper contact of interrupter 387, to ground as traced at the upper right contact of cam 350. When the interrupter 387 breaks its upper contact, magnet 625 deenergizes advancing switch 600 into position 2.

With switch 600 in position 2 a circuit is closed for operating the charging relay 396 extending from battery, winding of relay 396, conductor 615, brush 604 in position 2, conductor 631, thence as traced through the front contact of relay 361 to ground at the upper right contact of cam 350. Relay 396 upon energizing locks over its inner left front contact, the lower left contact of cam 394 to ground at the upper right contact of cam 350. A circuit is now closed for operating the subscriber's message register 105 extending from ground, winding of register 105, back contact of cut-off relay 101, conductor 114, terminal 380, brush 381, conductor 616 patched to conductor 616′, conductor 617′ patched to conductor 617, lower left and upper right contacts of cam 308, conductor 618 patched through conductor 619′ to conductor 619, brush 606, in position 2, conductor 620, inner left front contact of relay 396 to battery, through reistance 386.

After an interval more than sufficient to en-

able the operation of message register 105, the interrupter 387 upon again closing its upper contact, advances the timing switch 600 into position 3 over the same circuit which advanced it into position 2. From position 2 the timing switch is advanced rapidly by the interrupter 391, through positions 3 to 6 inclusive over a circuit extending from battery, winding of magnet 625, brush 601 and strapped terminals 3 to 6, inclusive, of its bank, conductor 621 to ground through contacts of interrupter 391. As brush 606 passes through position 4 the message register 105 is again operated over a circuit extending from its winding to conductor 616, thence over conductor 616′ patched thereto, the outer left contact of relay 611, conductor 622′ patched to conductor 622, the No. 4 terminal associated with brush 606, thence as traced to battery. Again as brush 606 passes through position 6, the message register 105 is operated for the third time over the circuit previously traced to the outer left front contact of relay 611, thence over conductor 623′ patched to conductor 623, the No. 6 terminal associated with brush 606, thence to battery. Three operations of the message register 105 are thus effected before the timing switch reaches position 7.

From position 7 the timing switch 600 is advanced by the slow timing interrupter 624 into its normal position, over a circuit extending from battery, winding of stepping magnet 625, brush 601 and strapped terminals 7 to 22, inclusive, associated therewith, conductor 626 patched through conductor 626′ to conductor 627, contacts of interrupter 624, conductor 628, right front contact of relay 302, conductor 608, to ground over the brush 603. Interrupter 624 is designed to close at long intervals so that the entire time for a revolution of timing switch 600 to be completed will require approximately five minutes. When the switch 600 reaches normal it is again advanced into position 2 as previously described where overtime registration begins. From this position the switch advances in a second revolution again operating the message register 105 as it passes through positions 2, 4 and 6. This cycle of operations is thus repeated every five minutes during the conversation and the register is operated three times during each cycle or each unit period of conversation.

When the calling subscriber hangs up to terminate the call, relay 330 deenergizes in turn opening the circuit of relay 351. A circuit is now established for relay 317 extending from battery, through its left winding, the lower left and upper right contacts of cam 316, the back contact of relay 351 to ground at contacts of interrupter 391. Relay 317, upon energizing, locks over its right winding, innermost right front contact to ground at the upper left contact of cam 336, disconnects the calling line from the left windings of repeating coil 360 at its back contacts, and closes a circuit for advancing the sequence switch 300 into position 17, if at the time the timing switch is in position 1 or 2. This circuit may be traced from battery, winding of magnet 300, lower right and upper left contacts of cam 301, conductor 629, brush 605 in position 1 or 2, conductor 630, front contact of relay 317, thence to ground at the upper left contact of cam 336. If the timing switch is in positions 7 to 22 at the time relay 317 energizes, the timing switch is immediately buzzed into normal position over a circuit extending from battery, through the winding of magnet 625, brush 602 and strapped terminals of its bank, interrupter contacts of magnet 625, strapped terminals 7 to 22 associated with brush 605, brush 605, conductor 630, contacts of relay 317 to ground at the upper left contact of cam 336. As soon as the timing switch reaches normal the circuit above traced for advancing sequence switch 300 is closed and the stepping circuit of magnet 625 is opened. If disconnection is initiated at the time the timing switch is advancing through positions 3 to 6, the sequence switch 300 is not advanced into position 17 until the timing switch reaches position 7 and the advance of the timing switch through positions 3 to 6 being directly under the control of interrupter 391, the operation of the subscriber's register in positions 4 and 6 is not interfered with. When the district sequence switch reaches position 17, the district selector and line finder restore in the well-known manner. In position 17 of the sequence switch 300, the timing switch is immediately buzzed into normal position over a circuit extending from battery, through the winding of magnet 625, strapped terminals 2 to 22, associated with brush 602, brush 602, interrupter contacts of magnet 625, conductor 610 to ground at the lower left contact of cam 336. Since the charging relay 396 became deenergized as soon as sequence switch 300 passed beyond position 15, no charging path over brush 606 is closed as the timing switch passes through positions 4 to 6.

Should the called subscriber hang up at the time the timing switch 600 is in position 2, relay 361 would release but the stepping path for magnet 625 would still be effective to advance the timing switch through the charging positions 3 to 6 since there would still be a circuit for magnet 625 extending from battery, winding of magnet 625, brush 601 and the No. 2 terminal of switch 600, conductor 614, the upper contact of cam 364, outer left front contact of relay 302, upper contact of interrupter 387, conductor 631, brush 604 in position 2, conductor 615, inner left front contact of charging relay 396, lower left contact of cam 394 to ground at the upper right contact of cam 350.

In order that the control of disconnection may not be interfered with should the calling subscriber hang up while the timing switch is passing through the registering positions 3 to 6, relay 351 is reoperated. It will be recalled that when the calling subscriber hung up, relay 351 was released and relay 317 was operated to advance the sequence switch 300 out of the talking position to initiate release. However, if relay 351 is thus released when the timing switch is in positions 3 to 6, relay 351 reoperates in a circuit from battery, through its winding, resistance 390, conductor 632, brush 605 in positions 3 to 6, conductor 630, right front contact of relay 317 to ground at the upper left contact of cam 336. Relay 351 in operating, at its right back contact disconnects the left winding of relay 317 from the interrupter 391 so that there will be no tendency for relay 317 to deenergize at each release of the stepping magnet 625 of the timing switch.

Charging calls to intermediate zones of the exchange area.

It will now be assumed that the calling subscriber has initiated a call to a less remote zone of the exchange for which but two operations of the message register 105 should be made for each unit period of conversation. For such a call, relay 611 is operated as before, but the district sequence switch is set into position 13. The circuits function exactly the same manner as before described, except that during each cycle of the timing switch 600 as the conversation proceeds, no charging path to the message register 105 is closed as the timing switch brush 606 passes through position 2. It will be recalled that in position 2 of the timing switch the circuit for operating the message register 105 extended from ground through the winding of register 105 over the back contact of relay 101, conductor 114, terminal 380, brush 381, conductor 616, patched through the conductors 616′ and 617′ to conductor 617, the lower left and upper right contacts of cam 306, conductor 618, patched through conductor 619′ to conductor 619, the No. 2 terminal and brush 606, conductor 620, the middle left front contact of charging relay 396 to battery. Since sequence switch 300 is in position 13, however, this circuit is open at the contacts of cam 306 and charging does not take place. Two charges are made, however, as previously described, as the switch 600 passes through positions 4 and 6 during each cycle thereof. Otherwise the circuits function as previously described.

Charging calls to nearby zones of the exchange area.

For calls to nearby zones, for which a single registration is required for each unit period of conversation, relay 611 is not operated from the sender and sequence switch 300 is set into position 14 for talking. Thus, during each cycle of the timing switch the circuit, previously traced for operating the message register each time brush 606 passes through position 2, is closed at contacts of cam 306. Since, however, relay 611 is not operated the paths, previously traced for operating the message register as the timing switch passes through positions 4 and 6, are open at the outer left front contact of relay 611. Thus, only one registration for each unit period of conversation is effected. Otherwise the circuits function as previously traced.

Free calls to certain zones of the exchange area.

It may be desirable to give subscribers free service to certain offices of the exchange area which are adjacent to the originating office. For such calls the relay 611 is not operated and the district sequence switch is set into position 13 for talking. As the timing switch 600 advances during each unit period of conversation, no paths for operating the message register 105 are closed since the path previously traced with the brush 606 in position 2 is now open at contacts of cam 306 and the paths traced with brush 606 in positions 4 and 6 are open at the outer left contact of relay 611.

Cross connections for changing the method of charging.

For the purpose of enabling wiring changes to be readily made whereby the method of charging calls may be changed, a cross-connecting rack is provided as shown at 650. In the preceding discussion it has been assumed that it was required that provision be made for charging calls at three rates on an elapsed time basis and also that provision be made for free calls. It may be desired to give flat rate service without consideration of the duration of the conversational period on single registration calls, but retain the timing of double and triple registration calls. To accomplish this the patching from the left to the right side of the connecting rack 650 would be as previously described except that conductor 627 would be patched to conductor 627′ rather than directly to conductor 626′. Thus, for calls requiring double or triple registrations for each unit period of conversation, relay 611 always being energized for such calls, the advance of the timing switch 600 from position 7 to normal is placed under the control of the timing interrupter 624, over a circuit extending from battery, through the magnet 625, brush 601, conductor 626, strapped to conductor 626′, the right contact of relay 611, conductor 627′, strapped to conductor 627, thence as previously traced to ground through contacts of the interrupter

624. For calls requiring but a single registration regardless of the duration of the call the timing switch 600 is arrested in position 7 of its first cycle since on such calls relay 611 is not energized and the circuit through the timing interrupter 624 is not closed. The timing switch therefore remains in position 7 until the termination of the call when it is restored to normal in the manner previously described. A single registration is thus made regardless of the length of the conversational period. Free calls are given as before described with relay 611 deenergized and the district sequence switch 300 in position 13.

Should it be desired to limit registrations to a maximum of two, the patching of conductor 623 to conductor 623′ would be omitted and thus the third registering impulse transmitted over brush 606 as it rotates through position 6 of each cycle would not be effective.

If there are but two zones of the exchange to be considered from a registration standpoint, then relay 611 is not necessary since the two talking positions 13 and 14 of the district sequence switch are sufficient to provide the proper registration discrimination. In this case conductors 612 and 613 are left unconnected at the connecting rack, conductor 619 is patched through conductor 619′ to conductor 618 as previously described, conductor 626 is patched through conductor 626′ to conductor 627, conductor 623 is left unconnected and conductor 622 is patched through conductors 622′, 633, 616′ and 617′ to conductors 616 and 617. With these connections it will be noted that all connections to the windings and contacts of relay 611 are eliminated. Therefore, if the district sequence switch 300 is set into position 14 the circuit previously traced for operating the register 105 will be closed over brush 606, conductors 619, 619′ and 618 during each cycle of the timing switch and as the brush 606 passes through position 4, the message register will be operated a second time over a circuit extending from battery, connected to brush 606, conductors 622, 622′, 633, 616′ and 616, thence to the message register. Since the conductor 623 extending from the No. 6 terminal associated with brush 606 is unconnected, no registration is effected as the timing switch passes through position 6. Two registrations are thus made for each unit period of conversation. With the district sequence switch 300 in position 13, the registration path over the No. 2 terminal of brush 606 is open at the contacts of cam 306 and only one registration is effected as the timing switch moves through position 4 of each of its cycles.

If there is but one charge to be made for a call for each unit period of conversation, with sequence switch 300 in position 14, and free calls with the sequence switch in position 13, the patching at the connecting rack 650 would be the same as just described except that conductor 622 would be left unconnected.

Another type of service may be provided for where it is desired to eliminate double and triple charging but to charge certain calls on a flat rate basis or a single charge regardless of the length of the call and other calls at a single charge rate for each unit period of conversation. This type of service may be provided by patching conductor 619 through conductor 619′ to conductor 616, patching conductor 627 through conductors 617′ and 616′ to conductor 618, patching conductor 626 through conductor 626′ to conductor 617 and leaving conductors 622, 623, 612 and 613 unpatched. With the connections made in this manner all connections to relay 611 are open and no effective circuits are established for operating the message register as the brush 606 of the timing switch passes through positions 4 and 6. If the district sequence switch has been set into the talking position 14, when the switch 600 rotates through position 2 a circuit is closed for operating the message register 105 which may be traced as before to conductor 616, thence over conductor 619′ and 619, brush 606, conductor 620, to battery. When the switch 600 reaches position 7, it is timed into normal position by the interrupter 624, over a circuit extending from battery, winding of magnet 625, brush 601, strapped terminals 7 to 22, conductors 626, 626′ and 617, lower left and upper right contacts of cam 306, closed in position 14, conductors 618, 616′, 617′ and 627, interrupter 624, conductor 628, battery, right front contact of relay 302, conductor 608 to ground at brush 603. Upon reaching position 1 the timing switch starts on a second similar cycle. Thus, for each unit period of conversation, one charge is registered on the message register 105. If, however, the sequence switch 300 is set into position 13 the circuit last traced for advancing the switch 600 from position 7 will not be closed and therefore the switch 600 will not advance through successive cycles during the conversation and but one charge will be made for the conversation regardless of the length of its duration. From position 7 the timing switch is restored in the manner previously described after the calling subscriber terminates the conversation.

Other methods of cross-connecting at the rack 650 for further types of service will suggest themselves, and it is obvious that by providing additional relays such as 611 controlled directly from the sender to designate additional charging zones of the exchange area, it would be possible to make more than three charges for each unit period of conversation.

What is claimed is:

1. In a telephone exchange system, a call-

ing line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, means for selectively operating said switches, means associated with one of said switches for altering circuits thereof in accordance with the class of the called line, a charging device for the 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 the advance of said timing switch in accordance with the setting of said altering means to variably operate said charging device, an interrupter, and means controlled by said interrupter to thereafter advance said timing switch slowly into normal position to measure off a predetermined conversational period, said timing switch advancing through similar cycles to repeatedly operate said charging device until said connection is released.

2. In a telephone exchange system, a calling line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, means for selectively operating said switches, means associated with one of said switches for altering circuits thereof in accordance with the class of the called line, a charging device for the 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 by the advance of said timing switch in accordance with the setting of said altering means to variably operate said charging device if said called line is of certain classes but not to operate said charging device if the called line is of another class, and means to thereafter advance said timing switch slowly into normal position to measure off a predetermined conversational period, said timing switch advancing through similar cycles until said connection is released.

3. In a telephone exchange system, a calling line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, a register sender, means for variably setting the registers of said sender, means controlled in accordance with the setting of said registers for selectively operating said switches, means associated with one of said switches for altering circuits thereof in accordance with the class of the called line, a charging device for the 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 by said timing switch during its advance in accordance with the setting of said altering means and the setting of said registers to variably operate said call charging device, an interrupter, and means controlled by said interrupter to thereafter slowly advance said timing switch into normal position to measure off a predetermined conversational period, said timing switch advancing through similar cycles to repeatedly operate said charging device until said connection is released.

4. In a telephone exchange system, a calling line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, a register sender, means for variably setting the registers of said sender, means controlled in accordance with the setting of said registers for selectively operating said switches, means associated with one of said switches for altering circuits thereof in accordance with the class of the called line, a charging device for the calling line, a timing switch, a relay associated with said timing switch and operative if said registers have registered the number of a called line of a particular class, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled by said timing switch during its advance in accordance with the setting of said altering means and the condition of said relay to variably operate said call charging device, an interrupter, and means controlled by said interrupter to thereafter slowly advance said timing switch into normal position to measure off a predetermined conversational period, said timing switch advancing through similar cycles to repeatedly operate said charging device until said connection is released.

5. In a telephone exchange system, a calling line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, a timing switch, a call charging device associated with said calling line, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled by said timing switch during its advance to operate said charging device, means operative if said calling line has been extended to certain called lines for slowly advancing said timing switch to normal to measure off a predetermined conversational period and to cause said timing switch to advance through similar cycles to repeatedly operate said charging device until said connection is released, and means to prevent said slow advance of said timing switch if the called line is of another class whereby said call is charged on a flat rate basis.

6. In a telephone exchange system, a calling line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, a timing switch, a call charging device associated with said calling line, 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 for selectively rendering said paths effective in accordance with the class of the called line, and means for at will altering the control of said last means over said operating paths.

7. In a telephone exchange system, a calling line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, a timing switch, a call charging device associated with said calling line, 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 for selectively rendering said paths effective in accordance with the class of the called line, and a cross-connecting rack for altering the selective control of said last means over said operating paths.

8. In a telephone exchange system, a calling line, a plurality of called lines of different classes, selector switches for extending the calling line to said called lines, a timing switch, a call charging device associated with said calling line, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, a plurality of operating paths for said charging device adapted to be closed by said timing switch during its advance, means for selectively rendering said paths effective in accordance with the class of the called line, means for slowly advancing said timing switch to normal for measuring off a predetermined conversational period, said timing switch then advancing through similar cycles to repeatedly operate said charging device until said connection is released, and a cross-connecting rack for enabling the selective control of said operating paths to be altered at will.

9. In a telephone exchange system, a calling line, a plurality of called lines, of different classes, selector switches for extending the calling line to said called lines, a timing switch, a call charging device associated with said calling line, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, a plurality of operating paths for said charging device adapted to be closed by said timing switch during its advance, means for selectively rendering said paths effective in accordance with the class of the called line, means for slowly advancing said timing switch to normal for measuring off a predetermined conversational period, whereupon said timing switch may be advanced through similar cycles to repeatedly operate said charging device until said connection is released, and a cross-connecting rack for enabling the selective control of said charging device to be altered and the repeated advance of said timing switch to be nullified at will.

10. In a telephone exchange system, a calling line, a called line, selector switches for extending the calling line to said called line, a timing switch, a call charging device associated with said calling line, means operative upon the response of the called subscriber to advance said timing switch through a plurality of positions, means controlled by said timing switch during its advance to operate said charging device, means for thereafter slowly advancing said timing switch to normal to measure off a predetermined conversational period, whereupon said timing switch may be advanced through similar cycles to repeatedly operate said charging device until said connection is released, and means controlled by said timing switch for preventing the release of said connection at the time said timing switch is advancing through the first portion of any cycle to operate said charging device.

In witness whereof, I hereunto subscribe my name this 24 day of October A. D., 1927.

ALFRED E. HAGUE.