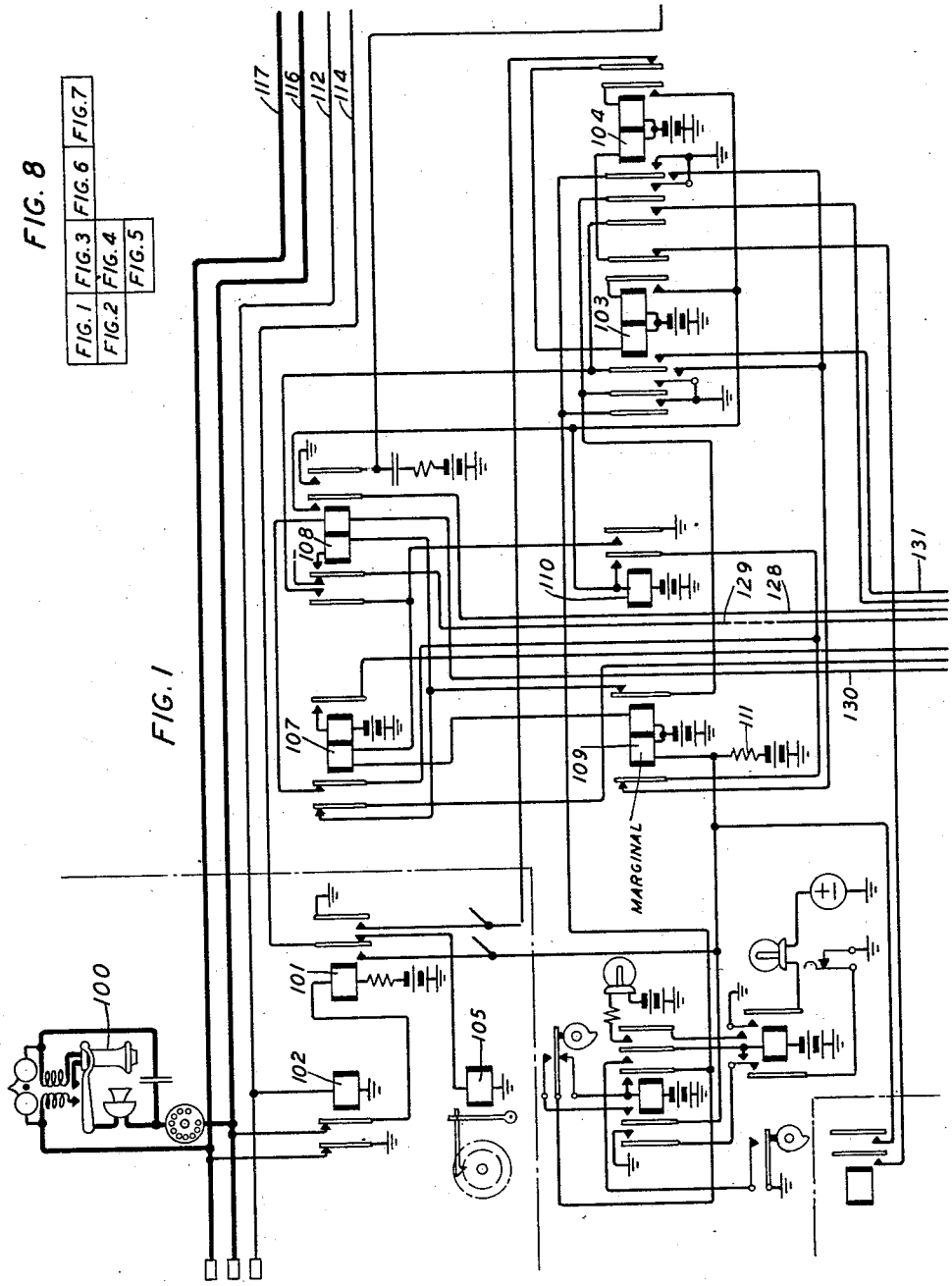
April 26, 1932. W. W. CARPENTER ET AL 1,855,598

TELEPHONE EXCHANGE SYSTEM

Filed Sept. 9, 1930 7 Sheets-Sheet 1

FIG. 8

FIG. 1	FIG. 3	FIG. 6
FIG. 2	FIG. 4	FIG. 7
	FIG. 5	



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TELEPHONE EXCHANGE SYSTEM

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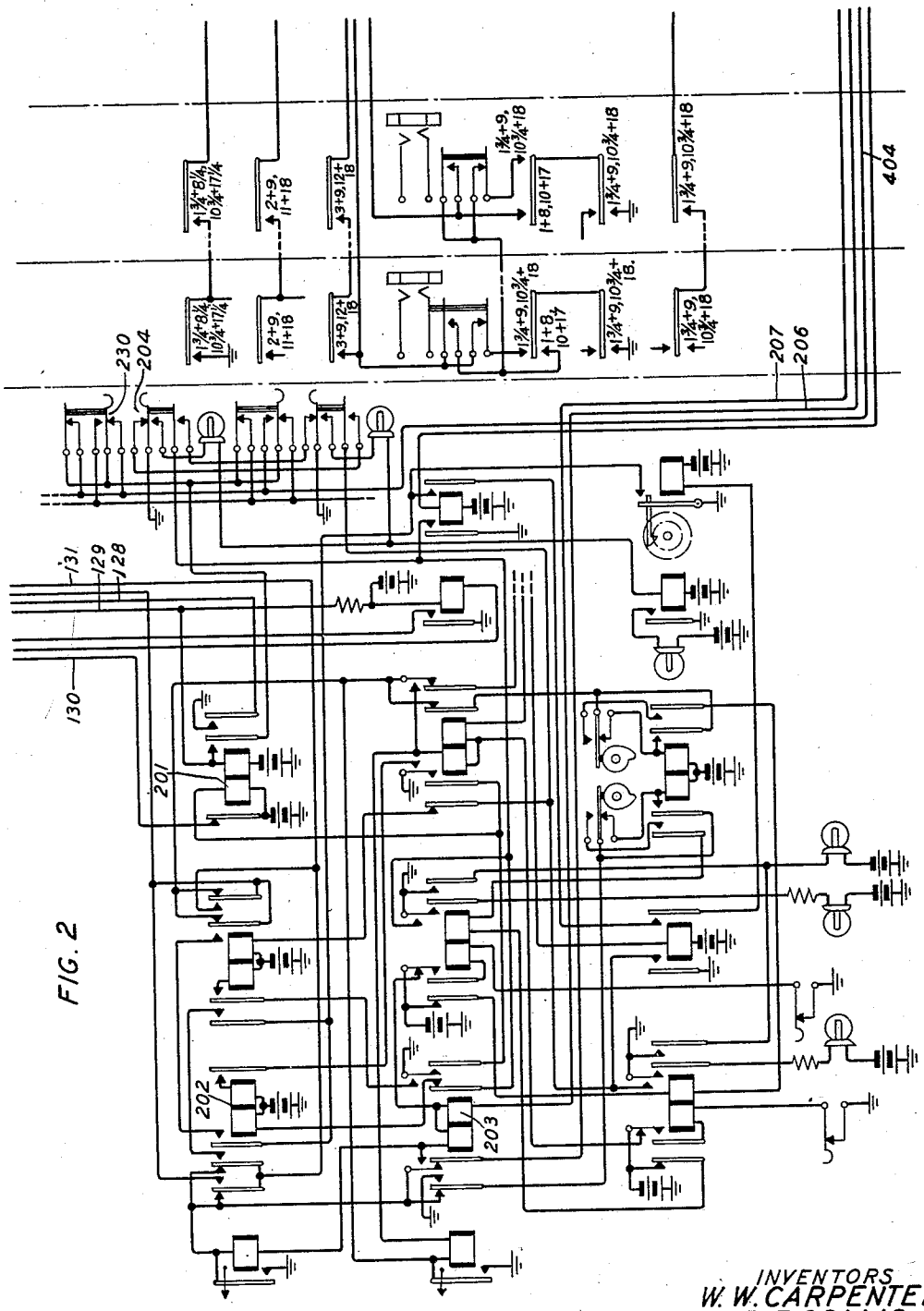

FIG. 2

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TELEPHONE EXCHANGE SYSTEM

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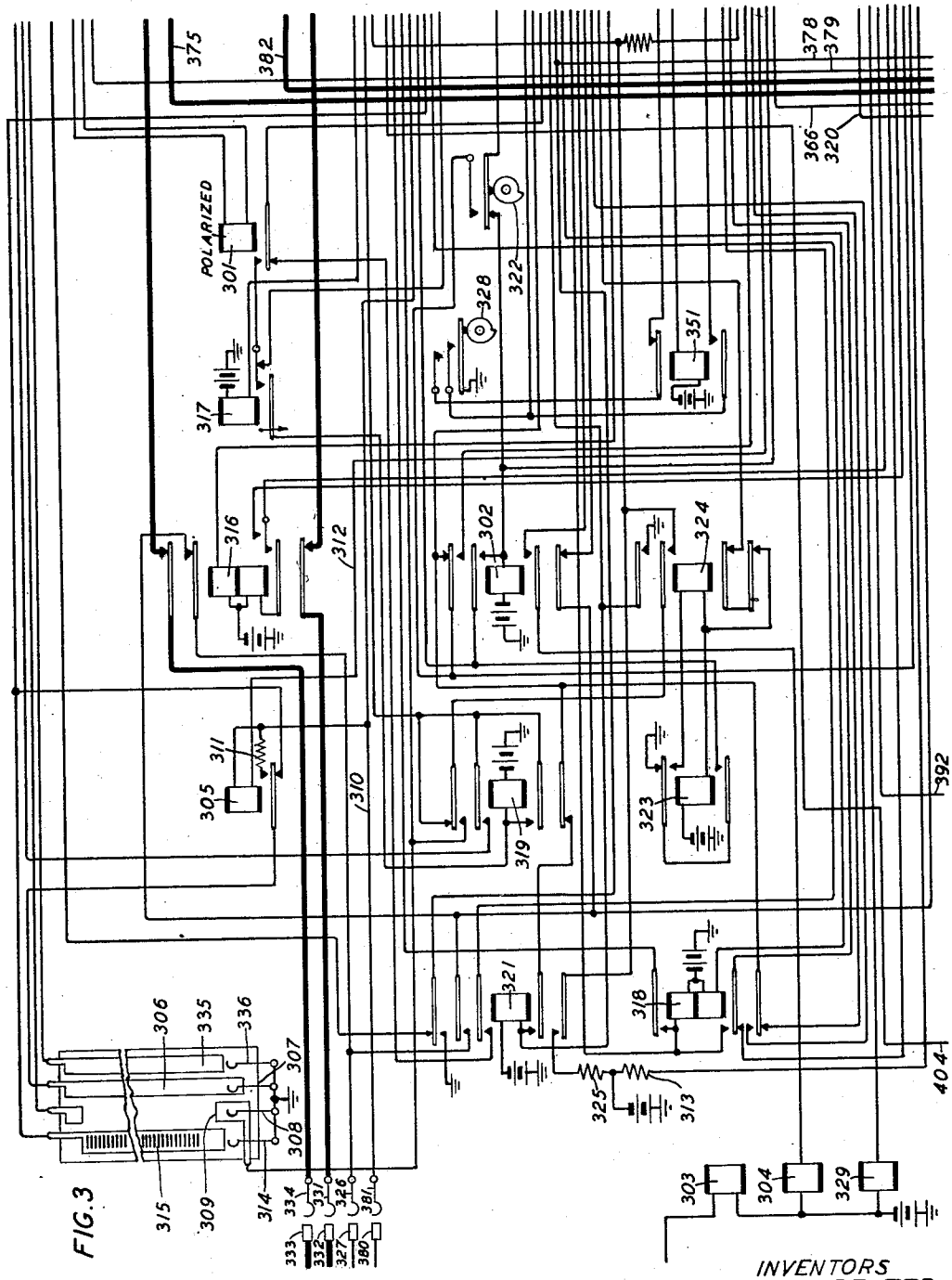

FIG. 3

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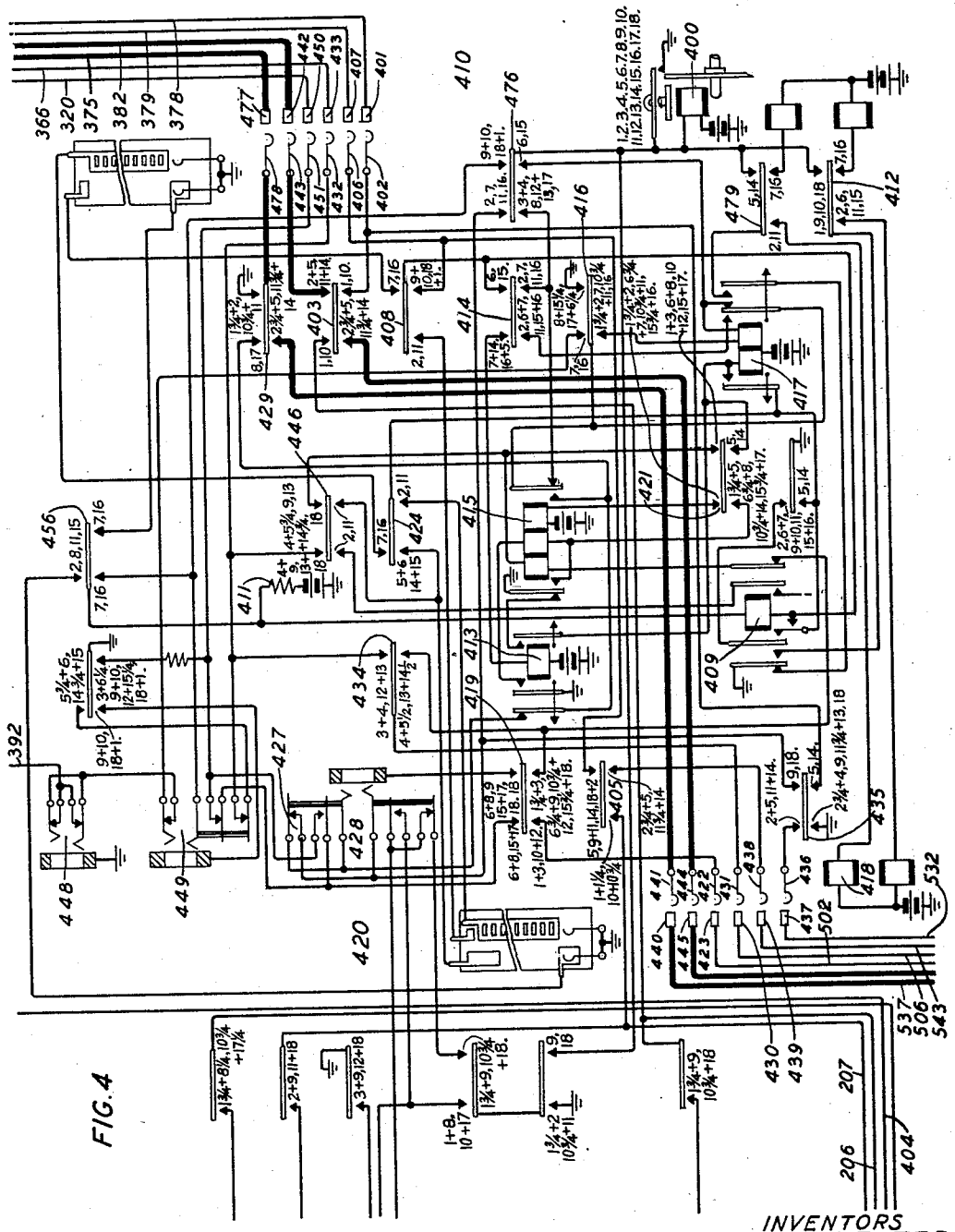

FIG. 4

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TELEPHONE EXCHANGE SYSTEM

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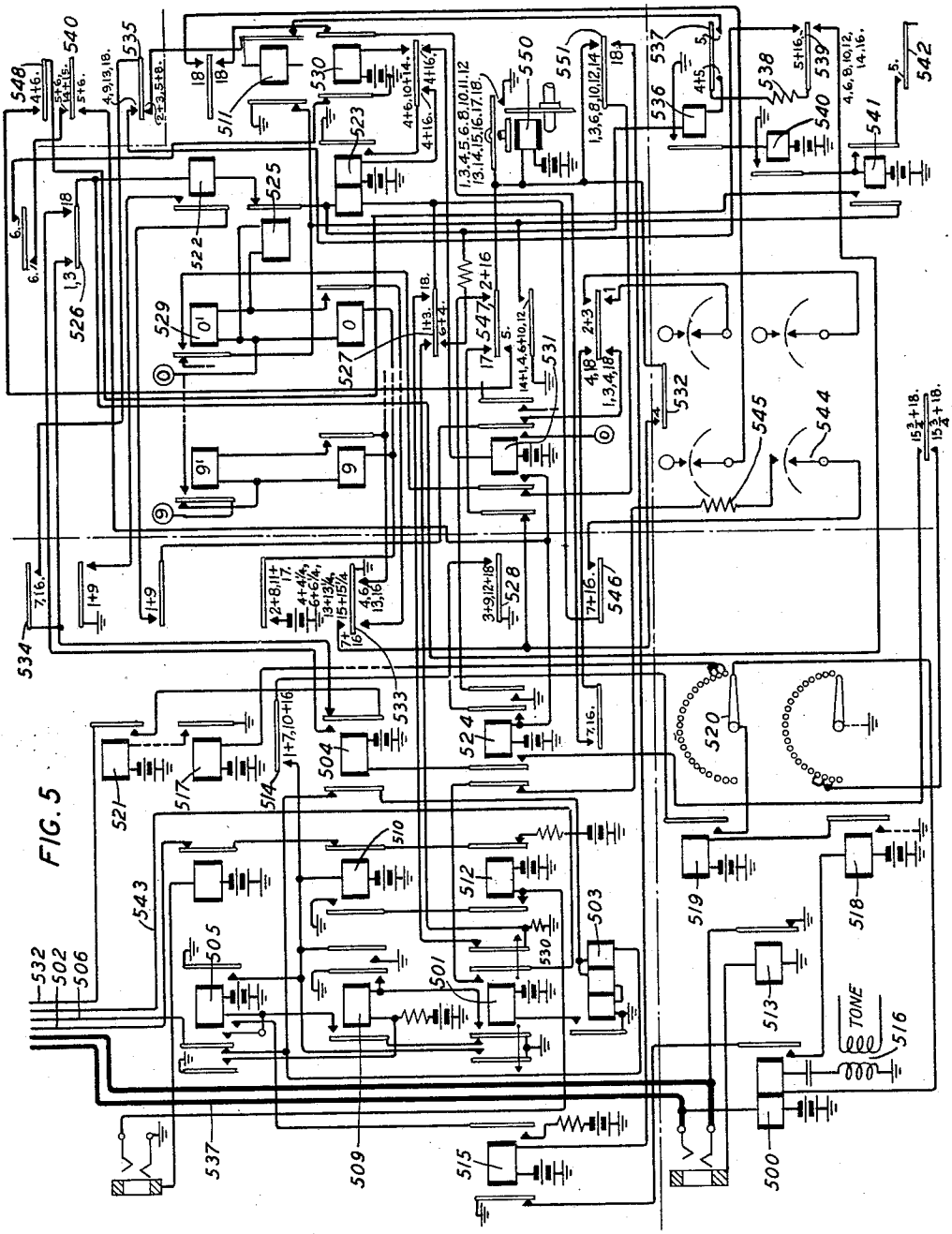

FIG. 5

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TELEPHONE EXCHANGE SYSTEM

Filed Sept. 9, 1930 7 Sheets-Sheet 6

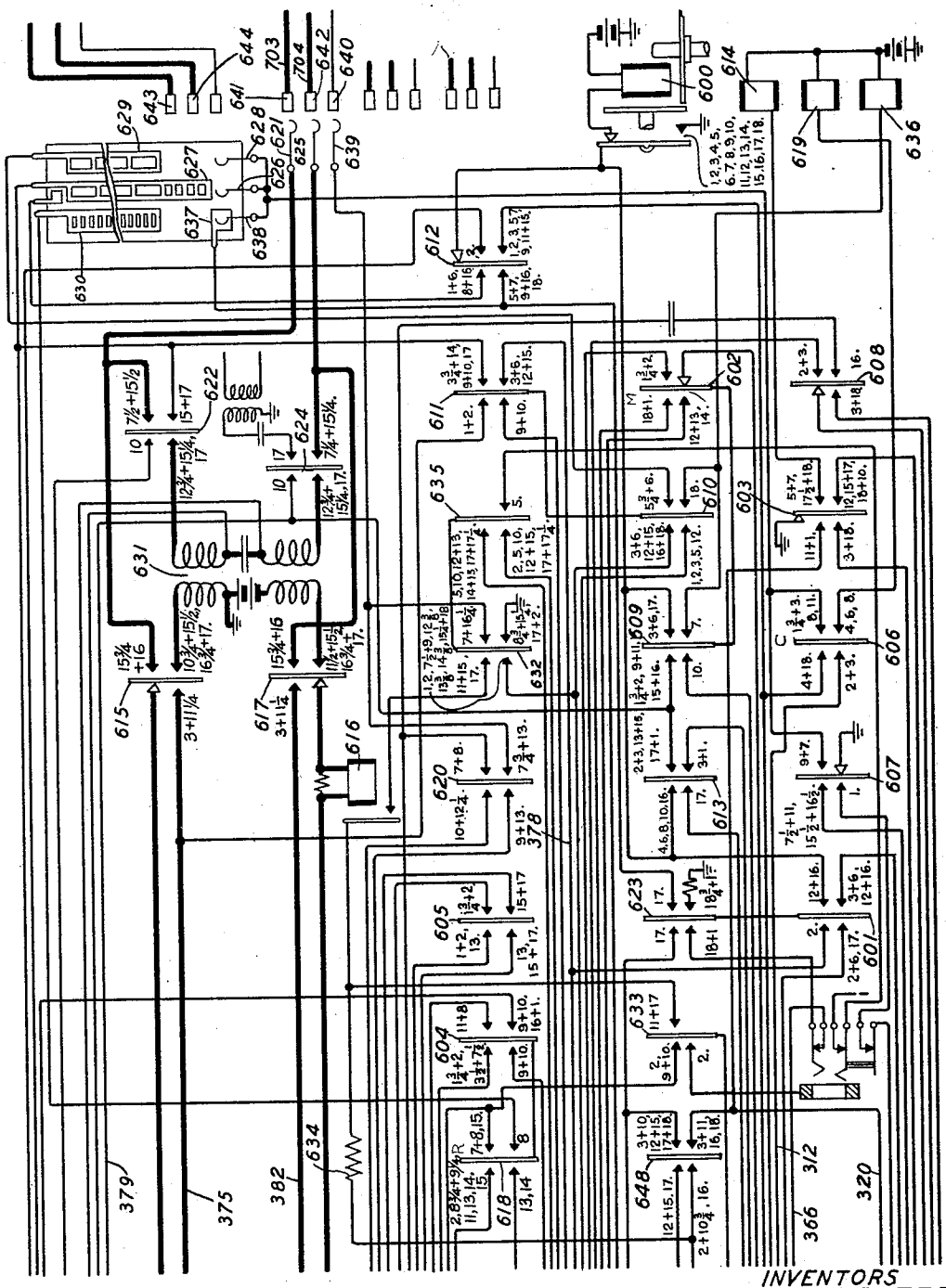

FIG. 6

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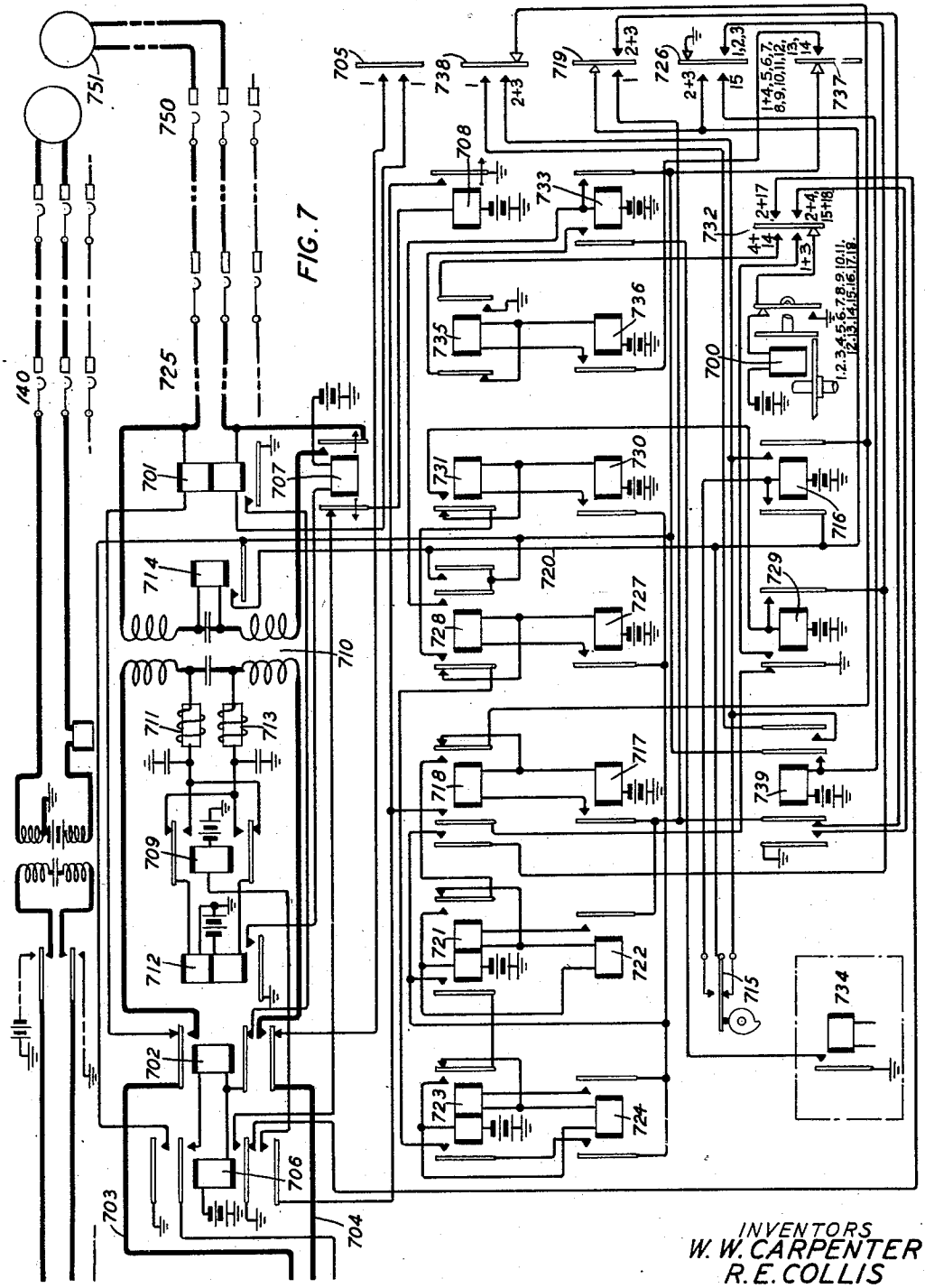
TELEPHONE EXCHANGE SYSTEM

Filed Sept. 9, 1930 7 Sheets-Sheet 7



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1,855,598

UNITED STATES PATENT OFFICE

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TELEPHONE EXCHANGE SYSTEM

Application filed September 9, 1930. Serial No. 480,660.

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.

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 interoffice 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 connection, 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 an interoffice trunk accessible to a district selector or office selector which is started upon the response of the called subscriber and advances through a cycle to measure the prescribed 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 initial portion of its cycle transmits reverse current impulses to the district selector for controlling the calling subscriber's message register, the number of register operations depending upon the zone of the exchange into which the interoffice trunk extends.

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 is started upon a second cycle. At this time, however through the provision of a relay 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.

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. 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.

The district selector and, if necessary, the office selector has access to a plurality of groups of trunks, certain of which groups may be used for local calls requiring but a single charge for the entire duration of conversation and other groups of which extend as interoffice trunks to different zones of the exchange area. For example, one group of trunks extending to one zone of the exchange area may each be equipped with a timing switch whereby calls extended thereover will be charged at a ten cent rate for the first five minutes of conversation and thereafter five cents for each additional five minutes, and another group of trunks extending to a more distant zone may each be equipped with a timing switch whereby calls extended thereover will be charged at a fifteen cent rate for the first five minutes of conversation and thereafter five cents for each additional five minutes. The trunks of each group over which local connections are established are not equipped with timing switches.

The control of the charging circuits at the district selector is in accordance with the well known practice exercised by a polarized supervisory relay which operates following the response of the called subscriber by a reversal of current over the trunk circuit. On calls over a local trunk but one current reversal is produced when a called subscriber answers and in response thereto the polarized relay of the district selector responds and prepares a charging circuit for the calling line message register which becomes effective to produce a single operation of the register upon the termination of the conversation.

When, however, a connection is established over an interoffice trunk equipped for causing multiple charges for a call in accordance with the elapsed time of the conversation, it becomes necessary to render the charging circuits of the selector capable of responding to the timing switch of the associated trunk to operate the register at intervals during the conversation. Provision is therefore made in such interoffice trunk circuits for causing a momentary reversal of the current flowing from the trunk circuit through the polarized relay of the district selector following the setting of the final selector upon the terminals of the called line and before the called subscriber responds which causes the charging circuits of the district selector to be so altered that subsequent reversals of current through the polarized relay of the district selector controlled by the timing switch of the trunk circuit following the response of the called subscriber, will cause the calling line message register to be operated upon each such reversal.

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 a group of calling lines;

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

Figs. 3 and 6 show a line finder-district selector link circuit, Fig. 3 showing the line finder and Fig. 6 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. 7 shows a trunk circuit outgoing from the district selector of Fig. 6 terminating in a distant office and having individual thereto a timing switch for controlling the calling subscriber's message register and schematically other selector switches for extending the connection to a called subscriber's line and schematically a trunk circuit and selector switches for establishing a local connection; and

Fig. 8 shows the manner in which Figs. 1 to 7 should be arranged to disclose the complete invention.

The invention has been embodied in a disclosure which is substantially like that of U. S. Patent No. 1,690,206 granted to A. Raynsford, on November 6, 1928, both the present disclosure and that of the Raynsford patent showing a skeletonized sender of the character shown in the more complete disclosure of U. S. Patent No. 1,589,402 granted to O. H. Kopp, June 22, 1926. Reference may be made to these patents for operations not completely disclosed 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 selector 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 by 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 Raynsford 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 three times for the first five minutes of conversation. When the subscriber at substation 100 removes his receiver from the switch-hook, a circuit is closed from battery through the winding of relay 101, back contact of relay 102, over the line loop 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, left back contact 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 contacts 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 contacts 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 600 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 contacts of relay 103, conductor 131, left back contacts of relay 202, inner left back contacts of relay 203, conductor 206, upper left and lower right contacts of cam 403, brush 402 and terminal 401, conductor 378, left contacts of cam 601, winding of relay 302 to battery. Relay 302 upon operating closes a circuit from battery through the winding of updrive magnet 304 of the line finder, inner lower front contact of relay 302, right contact of cam 602, upper front contact of relay 302 to ground at the lower right contact of cam 603. Relay 302 also locks over its inner upper front contact, the upper contacts of cam 604, 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 with the trip magnet 303 operated the proper set of brushes is tripped. As soon as commutator brush 308 engages segment 309, a circuit is closed thereover, the upper contacts of cam 605, 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, winding of relay 305, conductor 312, lower left and upper right contacts of cam 606 to ground at the right contacts of cam 607. Relay 305 operates in this circuit and closes a shunt around its winding from ground over commutator brush 307, segment 306, front contact of relay 305, resistance 311, conductor 310 and thence to battery in parallel through the left winding of relay 109 and resistance 111 over the circuit previously traced. 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 304 to cause the hunting movement of the line finder to cease and connects battery through resistance 313 the upper contacts of cam 608, lower back contact of relay 302, inner upper back contact of relay 316, brush 326, terminal 327, conductor 112 to ground through the winding of cut-off relay 102. Relay 102 thereupon operates disconnecting the line relay 101 of 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 right contact of cam 603, upper front contact of relay

302, lower right contact of cam 602, upper left contact of cam 609, 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 to search for an idle sender.

Relay 413 also closes a circuit from battery 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 432 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 in turn releasing magnet 418 and bringing 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 610, upper left contact of cam 611, 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 600 into position 3 which may be traced from battery through magnet 600, the lower right contact of cam 612, the lower front contact of relay 318, the upper back contact of relay 302 to ground at the lower right contact of cam 603. As sequence switch 600 advances from positions 2 to 3, relay 318 releases. With sequence switch 600 in position 3 busy battery is applied to the sleeve conductor 112 over line finder brush 326, the inner upper back contact of relay 316, the left contacts of cam 608 through resistance 313 to battery.

When sequence switch 400 reaches position 3 a circuit is closed from ground through the left and middle winding of relay 503, back contacts of relays 504 and 505, conductor 506, terminal 430, brush 431, upper contact of cam 434, brush 432, terminal 433, conductor 320, lower contacts of cam 648, to battery through the winding of relay 351 and in parallel over the upper right contact of cam 648 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 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 contacts of cam 615, upper back contact of relay 316, brush 334, terminal 333, conductor 117, through the subscriber's substation, conductor 116, terminal 332, brush 331, lower back contact of relay 316, winding of relay 616, left contacts of cam 617, 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. 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.

The calling subscriber now proceeds to dial the desired line number for setting the registers (not shown) and translator 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 to battery through the winding of relay 517, terminals and wiper 520, contact 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 a manner described in the afore-mentioned patent to O. H. Kopp and after the setting of the translator the class switch 540 is advanced into a position for making a full mechanical call. With sequence switch 600 in position 3, relay 318 is now energized over a circuit extending from battery through its upper winding, the lower left contact of cam 610, the lower right contact of cam 611, conductor 378, terminal 401 and brush 402 of district finder 410, the lower right and 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 left contact of cam 526, winding of sender stepping relay 522, back contact of counting relay 525, left winding of overflow relay 523, left contact of cam 527. resistance 530 to ground. Relay 522 and 318 operate in this circuit, relays 318 locking over its inner lower front contact, upper left contact of cam 610, thence over the circuit traced whereby it remains energized as the sequence switch 600 advances into position 4. Relay 318 also closes a circuit to advance sequence switch 600 into position 4 extending from battery through the winding of magnet 600, lower right contact of cam 612, lower front contact of relay 318, upper back contact of relay 302, and thence to ground over the lower right contact of cam 603.

With relay 318 operated and sequence switch 600 in position 4, a circuit is closed for the updrive magnet 619 extending from battery, winding of magnet 619, lower right and upper left contact of cam 606, lower front contact of relay 318, upper back contact of relay 302 to ground at the lower right contact of cam 603. The updrive magnet 619 causes the district selector switch shaft to move upwardly in a brush selecting movement. Each time that brush 626 engages a conducting segment of commutator strip 627 a holding circuit for relay 318 is established from ground at the right contact of cam 607, brush 626, segment 627, upper right contact of cam 611, upper left contact of cam 610, inner lower front contact and upper winding of relay 318 to battery. This holding ground intermittently shunts the sender stepping relay 522 and in the well known manner causes the successive operation of counting relays in the sender until the sender is satisfied in accordance with the distinct brush setting registered in the sender when counting relay 525 operates opening the fundamental circuit at the sender. Sequence switch 550 is thereupon advanced to position 3.

At the district selector upon the opening of the fundamental circuit and when the brush 626 engages the next insulating segment of commutator strip 627, relay 318 releases opening the circuit of updrive magnet 619 and closing a circuit for advancing sequence switch 600 to position 5, which circuit may be traced from battery, winding of magnet 600, upper left and lower right contact of cam 613, lower back contact of relay 318, upper back contact of relay 302 to ground at the lower right contact of cam 603. From positions 5 to 7 of sequence switch 600, a circuit is established for trip magnet 614 over the upper right contact of cam 603 to ground for preparing to trip the proper set of brushes when the district selector switch shaft is next advanced in a group selecting movement.

With sequence switch 600 in position 5 and sequence switch 550 in position 3 the fundamental circuit previously traced is again closed, and relays 522 and 318 operate as before. Relay 318 locks as previously described and closes the previously traced circuit for advancing sequence switch 600 to position 6. When sequence switch 600 arrives in position 6, updrive magnet 619 is again energized and the district selector shaft is moved upwardly to trip the selected brush set and then in a group selecting movement. As in the case of brush selection a holding circuit for relay 318 is prepared extending from ground at the right contact of cam 607, brush 628, commutator strip 629, the upper contacts of cam 610, the inner lower front contact and upper winding of relay 318 to battery, in shunt of the winding stepping relay 522. As the district selector shaft moves upwardly stepping relay 522 will be intermittently shunted operating counting relays until the sender is satisfied with respect to its district group registration, when counting

relay 525 will operate to open the fundamental circuit. As soon as brush 628 engages the next insulating segment of strip 629, relay 318 releases thereby opening the circuit of updrive magnet 619 advancing sequence switch 600 into position 7 over the circuit previously traced for advancing it into position 5.

In position 7 of sequence switch 600 relay 318 is operated in a circuit from battery, lower winding of relay 318, upper right contact of cam 618, upper left contact of cam 604, back contact of relay 305, commutator strip 306, brush 307, to ground. The operation of relay 318 closes a circuit from battery through the winding of sequence switch magnet 600, the lower right contact of cam 612, the lower front contact of relay 318, upper back contact of relay 302, to ground at the lower right contact of cam 603. Sequence switch 600 is advanced over this circuit to position 8.

From position 7¾ to 8 relay 318 locks over its upper winding and upper front contact, the right contacts of cam 620 to sleeve brush 639 and ground over the sleeve terminal of the first trunk, of the selected group provided that trunk is busy. The energizing circuit of relay 318 is opened in position 8. If the first trunk of the group is busy and relay 318 is held energized in position 8, a circuit is completed for the updrive magnet 619, extending from battery through the winding of magnet 619, lower right and upper left contacts of cam 606, lower front contact of relay 318, upper back contact of relay 302, to ground at the lower right contact of cam 603. The updrive magnet 619 is energized and causes the district selector switch shaft to move upwardly in search of an idle outgoing trunk. Relay 318 is held operated between trunk terminals over a circuit extending from battery through its lower winding, right contacts of cam 618, commutator segment 630, brush 638, upper contacts of cam 606, lower front contact of relay 318, upper back contact of relay 302 to ground at the lower right contact of cam 603. As soon as an idle trunk is reached, characterized by the absence of ground on its sleeve terminal, the locking circuit of relay 318 is opened and the relay releases in turn releasing the updrive magnet thereby bringing the selector to rest on the first idle outgoing trunk, which will be assumed to be the trunk disclosed in Fig. 7. The release of relay 318 closes a circuit from battery, winding of sequence switch magnet 600, upper left and lower right contacts of cam 613, lower back contacts of relay 318, upper back contact of relay 302 to ground at the lower right contact of cam 603, advancing sequence switch 600 to position 9.

As soon as relay 318 releases ground is connected to sleeve terminal 640 of the selected trunk circuit over brush 639, the upper right and lower left contacts of cam 632, the inner lower back contact of relay 318 to ground at the upper left contact of cam 607, to render the selected trunk busy. As soon as the sequence switch arrived in position 8¾ ground is connected over the right contacts of cam 632 to sleeve terminal 640 independent of relay 318, which ground is maintained until sequence switch 600 leaves position 15¼.

With sequence switch 600 in position 9, a circuit is established for relay 318 extending from battery through its lower winding, upper left contact of cam 633, front contact of relay 351, lower contacts of cam 604, commutator segment 335 and brush 336 to ground. Relay 318 operates and closes a circuit extending from battery through the winding of sequence switch magnet 600, lower right contact of cam 612, lower front contact of relay 318, upper back contact of relay 302, to ground at the lower right contact of cam 603 for advancing sequence switch 600 into the selection beyond position 10. In position 10 relay 318 remains energized over the circuit just traced.

Since the call is assumed to be to an office accessible directly through a district selector without passing through an office selector, relay 511 of the sender was operated as soon as sequence switch 550 reached position 2 and advanced the sequence switch, cams of which are shown on the left of the vertical dot and dash line of Fig. 5, into position 7 in the manner described in the aforementioned patent to O. H. Kopp whereupon relay 511 releases. When the counting relay 529 operates at the termination of district group selection with relay 511 deenergized, sequence switch 550 is advanced to position 4 over a circuit from battery, winding of magnet 550, upper contact of cam 551, inner left bank contact of relay 531, front contact of relay 529, left back contact of relay 511 to ground. From position 4 sequence switch 550 is advanced into position 5 over a circuit from battery, winding of magnet 550, contact of cam 532 to ground at the upper contact of cam 533.

A trunk test is now made to determine if the selected trunk, which in the present case terminates at a distant office in an incoming selector has been properly seized and is in normal condition. The test circuit may be traced in part from battery at the incoming selector, the brushes only of which have been indicated, upper winding of polarized relay 701, upper back contact of relay 702, conductor 703, terminal 641, brush 621, upper contacts of cam 622, upper back contact of relay 321, conductor 378, terminal 401, brush 402, lower right and upper left contacts of cam 435, brush 436, terminal 437, front contact of relay 621, right back contact of relay 504,

contact of cam 534, upper contact of cam 535, upper contact of cam 539, resistance 538, left contact of cam 537, winding of test relay 536, left winding of relay 523, contact of cam 546, translator brush 544 compensating resistance 545, left back contact of relay 524, right front contact of relay 507, conductor 543, terminal 439, brush 438, right contacts of cam 405, brush 406, terminal 407, conductor 379, upper left and lower right contacts of cam 624, brush 625, terminal 642, conductor 704, lower back contact of relay 702, contacts of cam 705, lower winding of polarized relay 701 to ground at the incoming selector.

The current flowing in this circuit operates test relay 536, in the sender but is not in the proper direction to operate relays 523 and 701. Relay 536 upon operating closes an obvious circuit for relay 540 which in turn closes an obvious circuit for relay 541, relay 541 locking over its right contact to ground on cam 542, until sequence switch 550 leaves position 5. With relay 541 operated a circuit is established for advancing sequence switch 550 into position 6 which may be traced from battery, winding of sequence switch magnet 550, lower contact of cam 547, contact of class switch cam 548, left contact of relay 541 to ground at the left back contact of relay 511. With sequence switch 550 in position 6, and district sequence switch 600 in position 10, a fundamental circuit is closed for controlling the incoming selector which may be traced in part from battery at the incoming selector over the circuit previously traced to the upper contacts of cam 535 in the sender, contacts of cam 539, winding of stepping relay 522, back contact of counting relay 525, lower contacts of cam 527, contact of cam 546, thence as traced to ground at the incoming selector. The control relay of the incoming selector and relay 522 in the sender operate over this circuit but polarized relay 701 in the trunk circuit does not operate.

The incoming selector 725 is controlled over this fundamental circuit in the well known manner following which the incoming selector hunts for an idle final selector 750. The fundamental circuit is then extended to the final selector which is then controlled by the sender to select the desired wanted line 751. After the completion of incoming and final selections a heavy positive impulse of potential is transmitted over the fundamental circuit from the sender thereby causing the operation of polarized relay 701. Relay 701 upon operating establishes a circuit from ground at its front contact over the inner lower back contact of relay 702 to battery through the winding of relay 706. Relay 706 operates closing a circuit for relay 708 extending from battery, winding of relay 708, back contact of relay 707 to ground at the inner lower front contact of relay 706. Relay 708 in turn closes a circuit for reversing relay 709 extending from battery, winding of relay 709, lower front contact of relay 706 to ground at the front contact of relay 708.

Relay 706 locks over the winding of relay 702, the inner upper front contact of relay 706, sleeve terminal 640, brush 639, to ground over the right contacts of cam 632, but as long as relay 701 remained energized relay 702 is shunted and does not operate in this locking circuit. When the heavy positive impulse ceases the shunt is removed and relay 702 operates, disconnecting the windings of relay 701 from the fundamental circuit and closing the fundamental circuit over trunk conductor 703, the upper front contact of relay 702, the upper left winding of repeating coil 710, retard coil 711, upper front contact of relay 709, upper winding of relay 712, to ground and connects the trunk conductor 704 over the lower front contact of relay 702, lower left winding of repeating coil 710, retard coil 713, lower front contact of relay 709 to battery through the lower winding of relay 712. The current flowing over the fundamental circuit to the sender is now in such a direction as to cause the operation of polarized overflow relay 523 in the sender, but is not of sufficient strength to operate relay 712 in the trunk circuit. With relay 523 operated relays 531, 524, and 504 are operated in the manner fully described in the aforementioned to O. H. Kopp.

With relays 531, 524, and 504 operated the sender sequence switch 550 is advanced to position 18 for controlling talking selection. Relay 351 in the district selector 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 600 is advanced into position 11 over a circuit extending from battery, winding of magnet 600, upper left and lower right contacts of cam 613, lower back contact of relay 318, upper back contact of relay 302, to ground at the lower right contact of cam 603. As the sequence switch enters position 11, ground is connected to conductor 320 at the upper left contact of cam 603 and thence 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 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

contacts. A circuit is therefore closed from ground over the left back contact of relay 507, left 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.

Talking selection

Sequence switch 600 is now advanced into position 12 over a circuit extending from battery through magnet 600, the lower right contact of cam 612, upper contacts of cam 606, to ground at the right contacts of cam 607. In passing into position 12 the subscriber's line becomes disconnected from the sender at contacts of cams 615 and 617. With sequence switch 600 in position 12 and sender sequence switch 550 in position 18, a circuit is established from battery through the upper winding of relay 318, lower left contact of cam 610, lower right contact of cam 611, conductor 378, terminal 401, brush 402, 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 winding of stepping relay 522, the back contact of counting relay 525, the lower and upper right contacts of cam 527, the right back contact of relay 507, resistance 530 to ground. Relays 318 and 522 energize in this circuit, relay 318 closing a circuit extending from battery through sequence switch magnet 600, lower right contact of cam 612, the lower front contact of relay 318, the upper left contact of cam 635 to ground at the lower right contact of cam 632. Relay 318 upon energizing locks to the fundamental circuit over its upper winding and inner lower front contact and the upper left contact of cam 610. As sequence 600 rotates out of position 12 toward position 16 ground is intermittently connected to the fundamental circuit in shunt of sender stepping relay 522 over the lower contacts of cam 632. When the sender is satisfied as to its talking selection setting, the fundamental circuit is opened at the sender through the operation of counting relay 525 and relay 318 deenergizes arresting the sequence switch 600 in its next stopping position. The sequence switch may be arrested in any one of three positions. Position 13 which is a multiple charging position for all connections to offices lying outside the local area, position 14 which is a single charge position for local calls and position 15 for connections to an operator's position. It will first be assumed that a call is established to a distant office for which a multiple charge must be made and that the sequence switch of the district selector is therefore positioned in position 13.

After the disconnection of relay 351 from conductor 320, this relay is held operated over a circuit extending through its winding, the lower contacts of cam 648 to ground at the upper left contact of cam 603. This circuit is maintained until sequence switch 600 leaves position 10¾. When sequence switch 600 enters position 11, relay 351 is held energized over resistance 634, the contact of relay 616 to ground over the upper left and lower right contacts of cam 632. When sequence switch 600 reaches position 11½, the calling subscriber's line is extended from conductor 117 over terminal 333, brush 334, the upper back contact of relay 316, the lower right contact of cam 615, the upper left winding of repeating coil 631, to ground and over conductor 116, terminal 332, brush 331, the lower back contact of relay 316, winding of supervisory 616, the lower right contact of cam 617, the lower left winding of repeating coil 631, to battery. Relay 616 is maintained energized in this circuit and maintains the holding circuit for relay 351 extending through the winding of relay 351, resistance 634, the front contact of relay 616 to ground over the upper left and lower right contacts of cam 632. Relay 351 is thus maintained operated until the calling subscriber releases the connection.

After talking selection is completed, relay 515 operates connecting battery to conductor 506 in parallel with the relay 505. The current over 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 thus 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. The link circuit of Fig. 4 now functions to restore the sender finder 420 thereof to normal, to hunt for and allot another line finder-district selector link for use on another call and to advance link sequence switch 400 to position 10, so that the link is ready to operate in response to the next call in the group of lines served thereby.

With the district selector sequence switch 600 in position 13, a circuit is established which may be traced from ground through the upper winding of relay 712, the upper front contact of relay 709, retard coil 711, the upper left winding of repeating coil 710, the upper front contact of relay 702, conductor 703, terminal 641, brush 621, the upper right and lower left contacts of cam 622, the upper right winding of repeating coil 631, winding of polarized relay 301, the lower right winding of repeating coil 631, lower contacts of

cam 624, brush 625, terminal 642, conductor 704, the lower front contact of relay 702, the lower left winding of repeating coil 710, retard coil 713, the lower front contact of relay 709 to battery through the lower winding of relay 712. Relays 301 and 712 operate in this circuit and perform functions which will be later described.

As sequence switch 600 advanced during talking selection into position 12¼ a circuit was established for relay 317 extending from battery through the winding of relay 317, the upper left and lower right contacts of cam 620, to ground at the right contacts of cam 632. As sequence switch 600 advanced out of position 12¼ relay 317 started to release but being slow to release does not fully release until after the energization of polarized relay 301 in the circuit previously traced through the winding of relay 712 in the trunk circuit. When therefore relay 301 operates a circuit is established for relay 319 extending from battery through the winding of relay 319, the front contact of relay 317, the front contact of relay 301, the lower left contact of cam 635, to ground at the lower right contact of cam 632, relay 319 operates and locks over its lower front contact, the lower contacts of cam 620, to ground at the right contacts of cam 632.

Relay 712 in the trunk circuit upon operating establishes an obvious circuit for relay 707 which upon operating opens the circuit of relay 708. Relay 708 in turn opens the circuit of reversing relay 709 which thereupon releases and reverses the connection of ground and battery through the windings of relay 712 and the left windings of repeating coil 710, so that current now flows in such a direction through the winding of polarized relay 301 that relay 301 deenergizes. The reversed condition of battery connected to the winding of polarized relay 301 is therefore effective for only a short interval. When relay 707 operated it connected the winding of polarized relay 714 and the right windings of repeating coil 710 to the tip and ring trunk conductors extending to the incoming selector.

When the calling subscriber at substation 751 answers polarized relay 714 is operated and connects ground from the upper front contact of relay 706 over the contacts of relay 714 conductor 720 to the middle contact of interrupter 715. As soon as the interrupter 715 closes its upper contact a circuit is established from battery through the winding of relay 716, the upper contact of interrupter 715, thence as traced to ground at the upper front contact of relay 706. Relay 716 upon operating locks over its left contact to ground at the upper front contacts of relay 706 independent of the contact of interrupter 715 and at its right contact establishes a circuit for relay 717 which may be traced from battery through the winding of relay 717, the right back contact of relay 718, the right contact of relay 716, the lower contact of interrupter 715 and thence as traced to ground at the upper front contact of relay 706. Relay 717 upon operating locks in a circuit through its winding, the winding of relay 718, the front contact of relay 717, the left contacts of cam 719, thence to ground on conductor 720. Relay 718 is shunted in this locking circuit until the interrupter 715 opens its lower contact whereupon relay 718 operates in the locking circuit of relay 717. Thus through the operation of interrupter 715 and relays 717 and 718, relay 718 does not operate for a minimum of five-tenths of a second and a maximum of one and five-one hundredths seconds after the called subscriber answers.

On the next closure of the bottom contact of interrupter 715 with relay 718 operated a circuit is closed from ground on conductor 720, lower contact of interrupter 715, right front contact of relay 716, right front contact of relay 718, right back contact of relay 721, winding of relay 722 to battery through the left winding of relay 721. Relay 722 operates in this circuit but relay 721 being marginal does not. Relay 722 upon operating locks from battery through the left winding of relay 721, winding of relay 722, right winding of relay 721, front contact of relay 722, left contacts of cam 719 to ground on conductor 720 shunting the right winding of relay 721. Upon the next opening of the lower contact of interrupter 715, this shunt is opened and relay 721 operates. When interrupter 715 again closes its lower contact relay 722 becomes shunted from ground on conductor 720, left contacts of cam 719, front contact of relay 722, right winding of relay 721, winding of relay 722, right front contact of relay 721, right front contact of relay 718, right front contact of relay 716, lower contact of interrupter 715 to ground on conductor 720 and relay 722 releases. Relay 721 is, however, held operated over its left winding and right front contact to ground on conductor 720. On the next opening of the lower contact of interrupter 715, the holding circuit of relay 721 is opened and relay 721 releases.

During the operating of relay 721 a circuit is established for relay 724 which may be traced from battery, left winding of relay 723, winding of relay 724, right back contact of relay 723, left contact of relay 721 outer left contact of relay 718, right contacts of cam 726 to ground. Relay 724 operates in this circuit but relay 723 being marginal does not operate. Relay 724 locks over the left winding of relay 723, winding of relay 724, right winding of relay 723, right contact of relay 724, to ground as traced at the right contacts of cam 726. When relay 721 releases, the shunt around the right winding of relay 723, from the left contact of relay

721, right back contact of relay 723, right winding of relay 723, right contact of relay 724, to the left contact of relay 721 is opened at the left contact of relay 721, and relay 723 operates. Relays 723 and 724 being both operated, a circuit is established for relay 727, extending from battery, winding of relay 727, left back contact of relay 728, left contacts of relays 723 and 724, outer left contact of relay 718 to ground at cam 726. Relay 727 operates and locks through the winding of relay 728 and its own front contact, the outer left contact of relay 718, to ground at the right contacts of cam 726, but relay 728 being shunted does not operate.

When relay 721 releases, the circuit of relay 722 is again established and under the control of interrupter 715, relays 721 and 722 both operate and release in a second cycle. Relay 721 again operating causes the shunting of relay 724 over a circuit extending from the left contact of relay 721, the right front contact of relay 723, winding of relay 724, right winding of relay 723, right contact of relay 724, to the left contact of relay 721. Relay 723 upon releasing opens the shunt around the winding of relay 728 and relay 728 operates. When relay 721 again releases in its second cycle the holding circuit of relay 723 is opened and relay 723 releases. Relay 728 upon operating connects the middle spring of interrupter 715 over the outer right front contact of relay 728 directly to ground at the upper contact of relay 706 independent of supervisory relay 714. Thus through the operation of relays 721 to 724 inclusive under the control of interrupter 715 a time interval of 1.65 seconds is measured from the time relay 718 operates to the time relay 728 operates. During this timing interval if the calling subscriber releases or flashes his switchhook all relays of the trunk circuit which have been operated will release. Relay 728 thus operates after a total interval following the response of the called subscriber of 2.15 to 2.75 seconds. This circuit arrangement is necessary in order to prevent possible false operation of the subscriber's message register in case of a release by the called subscriber during the first two seconds of the delay period.

At the time relay 718 operated following the response of the called subscriber, it closed a circuit for reversing relay 709 extending through the winding of this relay, lower front contact of relay 706, inner left front contact of relay 718 to ground at the back contact of relay 729. Relay 709 reverses the direction of the current flowing through the polarized supervisory relay 301 of the district selector to cause its operation. Relay 721 and 722 again operate and release in a third cycle under the control of interrupter 715 again causing the operation of relays 723 and 724. With relay 728 operated when relays 723 and 724 both become operated, a circuit is established for relay 730 over a circuit extending from battery, winding of relay 730, back contact of relay 731, left front contact of relay 728, left contacts of relays 723 and 724, outer left contact of relay 718 to ground at the right contacts of cam 726. Relay 730 operates and locks through the winding of relay 731 and its own front contact over the left front contact of relays 718, to ground at cam 726, but relay 721 does not operate in this locking circuit since its winding is shunted until relay 724 releases. Under the control of interrupter 715 relays 721 and 722 are again operated and released in a fourth cycle causing the release of relays 723 and 724 and the removal of the shunt from around the winding of relay 731, whereupon relay 731 operates.

As the interrupter 715 continues to close and open its lower contacts, relays 721 and 722 are operated and released through two more complete cycles causing the operation of relays 723 and 724 during the first of these cycles and their release during the second of these cycles. Upon the operation of relays 723 and 724, with relay 731 operated, a circuit is closed from battery through the winding of relay 729, the left front contacts of relays 731 and 728, the left front contacts of relays 723 and 724, the outer left contact of relay 718 to ground at the right contacts of cam 726. Relay 729 operates and locks over its right contact to ground at the right contacts of cam 726, at its left back contact opens the circuit of reversing relay 709 and at its left front contact establishes a circuit for advancing sequence switch 700 into position 2. This circuit may be traced from battery through the winding of magnet 700, lower left contact of cam 732, to ground at the left front contact of relay 729. When sequence switch 700 advances, all operated relays of the trunk circuit except relays 702, 706, 712 and 714 release. This ends the first charging period. Through the control of interrupter 715 relays 717, 718, 721, 722, 723, 724, 727, 728, 730 and 731 have thus been operated and a period is measured so that relay 729 is not operated for 5.5 seconds after relay 718 operates. During this period the reversing relay 709 is held operated to operate relay 301 in the district selector to enable the district delay circuit to function.

Reverting now to the operation of the circuit of the district selector it will be recalled that relay 319 was operated and locked and that relay 317 released. When therefore the called subscriber answers and relay 301 operates a circuit is established for relay 302 extending from battery, winding of relay 302, lower contact of interrupter 322, left contacts of cam 618, normal contacts of relay 317, front contact of relay 301, lower left contact of cam 635, to ground at the lower

right contact of cam 632. Relay 302 operates and locks over its inner upper front contact, the upper right contact of cam 604, the upper left contact of cam 618, normal contact of relay 317, front contact of relay 301 to ground at the lower right contact of cam 632 as traced independent of interrupter 322. As soon as interrupter 322 closes its upper contact a circuit is now established for relay 323, extending from battery, winding of relay 323, lower back contacts of relay 324, lower right contact of cam 602, upper front contact of relay 302, upper contact of interrupter 322, left contacts of cam 618, thence to ground at the lower right contact of cam 632 over the front contact of relay 301. Relay 323 operates and locks through the winding of relay 324 and its own front contacts to ground over the locking circuit of relay 302 but relay 324 does not operate since its winding is at the time shunted over the upper contact of interrupter 322. When however interrupter 322 opens its upper contact, relay 324 operates and closes an obvious circuit for relay 321.

The operation of relays 302, 323 and 324 under the control of interrupter 322 has introduced a delay from the time relay 301 operated following the response of the called subscriber before applying charging battery for operating the calling line message register to avoid a false charge should the called subscriber release or flash his switchhook. If the called subscriber does not release during this period and relay 301 remains operated until relay 324 becomes operated, charging battery is applied through resistance 325, the lower front contact of relay 321, the inner upper front contact of relay 324, the upper front contact of relay 319, the left contacts of cam 605, conductor 310, brush 381, terminal 380, conductor 114, back contact of relay 101 to ground through the calling line message 105. At the end of the first charging period when reversing relay 709 released through the operation of relay 729 and in turn released relay 301, the circuit for holding relays 302, 323, 324 and 321 is opened at the contacts of relay 301.

Returning now to a consideration of the operation of the trunk circuit of Fig. 7, it will be recalled that sequence switch 700 was advanced to position 2 thereby releasing the operated counting relays 717, 718, 721, 722, 723, 724, 727, 728, 730 and 731. With sequence switch 700 in position 2, when the interrupter 715 closes its lower contact, a circuit is again established for relay 717 extending from battery, winding of relay 717, right back contact of relay 718, lower contacts of cam 738, lower contact of interrupter 715 to ground over the front contact of relay 714 and the upper front contact of relay 706. Relay 717 operates and locks through the winding of relay 718, the front contact of relay 717, the left back contact of relay 739, the right contact of cam 719, the ground at the upper contacts of cam 726 but relay 718 does not operate in this circuit until the interrupter 715 opens its lower contact. When relay 718 operates it again closes the circuit of reversing relay 709, over a circuit extending from battery, winding of relay 709, lower front contact of relay 706, inner left front contact of relay 718, to ground at the back contact of relay 729. Relay 301 in the district selector now receives current in the proper direction to cause its operation and in turn causes the operation of relays 302, 323, 324, and 321 in the manner previously described, to apply charging current for operating the calling subscriber's message register 105 a second time.

The counting relays of the test circuit are now operated under the control of interrupter 715 in the manner previously described. When after an interval of approximately five seconds relay 731 operates, the circuit of 729 is again established and relay 729 operates to release reversing relay 709 and advances sequence switch 700 from position 2 to position 3. The release of reversing relay 709 releases the polarized relay 301 in the district selector whereupon the relays 302, 323, 324, and 321 are again released. When sequence switch 700 advances out of position 2 the counting relays of the trunk circuit are released and relay 729 is also released. In a similar manner the counting relays of the trunk circuit again function through another cycle causing a further reversal of current to the district selector through the operation and release of reversing relay 709 and the further transmission of an operating impulse to the calling subscriber's message register 105 through the operation of relay 301 and relays 302, 323, 324 and 321 of the district selector circuit. Following this, sequence switch 700 is advanced from positions 3 to 4 under the operation of relay 729 and in position 4 all operated counting relays and relay 729 of the trunk circuit become released. It will thus be apparent that the calling subscriber's message register 105 has been operated three times for registering a fifteen cent charge.

Returning now to a consideration of the operation of the trunk circuit of Fig. 7, when relay 728 operated the first time it closed a circuit for relay 733 extending from battery through the winding of relay 733, inner right front contact of relay 728, to ground at the upper front contact of relay 706. Relay 733 operates in this circuit and locks over its right contacts to ground at the upper front contact of relay 706 independent of relay 728, so that when relay 728 released it remained operated. At its left front contact relay 733 closes a circuit from office timing circuit 734, left front contact of relay 733,

left back contact of relay 735 to battery through the winding of relay 736. Relay 736 operates in this circuit and locks through the winding of relay 735, the front contact of relay 736, the contacts of cam 737 to ground at the upper front contact of relay 706, but relay 735 being shunted by ground supplied from the office timing circuit does not operate in this locking circuit until the timing circuit after a thirty second interval has removed the ground.

With relay 735 operated, sequence switch 700 is advanced to position 5 over a circuit extending from battery, winding of magnet 700, upper left contact of cam 732 to ground at the front contact of relay 735 as soon as the charging impulses have been sent. In leaving position 4 the locking circuit of relays 735 and 736 is opened at the right contact of cam 737 and these relays release. With sequence switch 700 in position 5, relays 735 and 736 are again operated under the control of office timing circuit 734 and sequence switch 700 is advanced into position 6 under the control of relays 735 and 736. In a similar manner sequence switch 700 is advanced from position to position into position 15. The advance of sequence switch 700 from position 4 into position 15 under the control of timing circuit 734 and relays 735 and 736 at thirty second intervals has thus measured off a maximum of five and one half minutes or a minimum of five minutes for the first talking period.

With sequence switch 700 in position 15, a circuit is established for relay 739 extending from battery, winding of relay 739, to ground over the lower left contact of cam 726. Relay 739 operates and locks over its inner right front contact to ground at the upper contact of relay 706 and closes a circuit extending from ground at its left front contact, the lower right contact of cam 732, to battery through the winding of sequence switch magnet 700 for advancing sequence switch 700 from position 15 into its normal position 1. If at this time both the calling and called subscribers are still conversing and relays 702 and 706 controlled from the calling subscriber's line and relay 714 controlled from the called subscriber's line are energized, the counting relays of the trunk circuit again function as previously described to reoperate and release reversing relay 709 whereby relay 301 in the district selector again functions to cause the calling line message register 105 to again operate to charge for an overtime period of conversation. As previously described, when relay 729 is operated to release reversing relay 709, the sequence switch 700 is advanced to position 2 whereupon the operated counting relays and relay 729 become released.

Since at this time relay 739 is operated, the sequence switch 700 is advanced directly into position 5 over a circuit extending from ground at the left front contact of relay 739, the lower right contact of cam 732 to battery through the winding of sequence switch magnet 700. Since the circuit previously traced for operating the counting relays under the control of interrupter 715 when sequence switch 700 is in positions 2 and 3, is opened at the left back contact of relay 739, consequently reversing relay 709 is not operated to cause further operation of the calling line message register. From position 5 sequence switch 700 is advanced in the manner previously described into position 15 under the control of office timing circuit 734 and five minutes is thus measured off for the overtime period of conversation. From position 15 sequence switch 700 is advanced to normal under the control of relay 739. Thus for the overtime period of five minutes the calling line message register 105 is operated once. If conversation continues sequence switch 700 advances through similar cycles until the connection is released by the calling subscriber or the called subscriber hangs up and releases relay 714. A single charge is thus made for each overtime period of five minutes.

It will of course be obvious that by slight changes in the wiring and the cutting of sequence switch cams of sequence switch 700, other charges than fifteen cents can be arranged for and the length of the timing period changed to suit various plans of charging.

Release of connection

At the end of the conversation when the calling subscriber restores his receiver to the switchhook, relay 616 releases in turn opening the circuit of relay 351. Relay 351 remains locked over a circuit extending through its winding, resistance 634, the right contact of cam 633, the front contact of relay 351 to ground at the lower contact of interrupter 328 until interrupter opens this contact. When relay 351 finally releases a circuit is closed upon the next closure of the contacts of interrupter 328 extending from ground thereover, the back contact of relay 351, the upper contacts of cam 648, to battery through the upper winding of relay 316. Relay 316 operates and locks over its lower winding and inner lower front contact to ground at the lower left contact of cam 603, at its lower and upper back contacts disconnects the brushes 331 and 334 of the line finder from the left windings of repeating coil 631, at its inner upper back contact opens the holding circuit of the calling line cut-off relay 102 thereby causing its release, and at its outer lower front contact establishes a circuit extending from ground at the lower left contact of cam 603 over the front contacts of relay 316, right contacts of cam 601 to battery

through the winding of sequence switch magnet 600 thereby advancing sequence switch 600 into position 17.

With sequence switch 600 in position 17 a circuit is established for relay 302, extending from battery, winding of relay 302, lower left contact of cam 601, upper left contact of cam 623, upper contacts of cam 648, back contact of relay 351 to ground at interrupter 328. Relay 302 upon operating locks over its inner upper front contact, right contacts of cam 604, commutator segment 335, brush 336, to ground and establishes a circuit for advancing sequence switch 600 into position 18 which may be traced from battery through the winding of magnet 600, upper right contact of cam 609, upper front contact of relay 302, to ground at the lower right contact of cam 603.

With sequence switch 600 in position 18, a circuit is established for the downdrive magnet 329 of the line finder which may be traced from battery, winding of magnet 329, upper left contact of cam 602, upper front contact of relay 302, to ground at the lower right contact of cam 603. Magnet 329 operates to drive the line finder shaft into normal position when 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 600, a circuit is also established from battery, winding of down drive magnet 636 of the district selector, lower right and upper left contacts of cam 610, lower contacts of cam 632 to ground for driving the district selector shaft into normal position. When the shaft reaches normal position a circuit is established from battery through the winding of sequence switch magnet 600, lower left contact of cam 612, normal commutator segment 637, brush 638 to ground at the right contacts of cam 607 for advancing sequence switch 600 into normal position.

Upon leaving position 15¼ ground is removed at the lower right contact of cam 632 from sleeve brush 639 thereby opening the holding circuit of relays 702 and 706 of the trunk circuit. The circuit of relay 712 is also opened at contacts of cams 622 and 624 and relay 712 releases in turn releasing relay 707. Relay 707 upon releasing opens the trunk circuit loop extending through the winding of relay 714 toward the incoming selector thereby initiating the release of the incoming selector and final selector employed in establishing the connection. Relay 706 upon releasing closes a circuit extending from ground at its lower back contact, the upper right contact of cam 732, to battery through the winding of sequence switch magnet 700, for advancing this sequence switch from any position in which it may be standing into normal position. With sequence 700 in normal position and relays 702, 706, 712 and 714 released, all operated relays of the trunk circuit become released. All operated apparatus employed in the extension of the connection has now been restored to normal condition in readiness for use on another call.

Calls to the local area

In the foregoing description it was assumed that the call initiated by the calling subscriber was to a subscriber's line located outside the local area and that therefore a multiple charge of more than five cents was made therefor and charges were made for overtime periods of conversation. A call to a subscriber's line in the local area will now be discussed. Calls of this character require but a single charge regardless of the duration of the conversation and are established directly from the district selector or office selector to a local incoming selector without the employment of the trunk circuit of the character disclosed in Fig. 6.

For a call within the local area the district sequence switch 600 is set into talking selection position 14. As before described, when sequence switch 600 advances from position 12 towards position 14 during its talking selection movement relay 317 operates When sequence switch 600 reaches position 14 the circuit of polarized relay 301 is established from battery at the incoming selector 740, terminal 643, district selector brush 621, upper right and lower left contacts of cam 622, upper right winding of repeating coil 631, winding of relay 301, lower right winding of coil 631, lower contacts of cam 624, brush 625, terminal 644, thence to ground at the incoming selector 740. The current flowing through the winding of relay 301 is not in this case in the proper direction to cause its operation. Therefore when relay 317 releases, after sequence switch 600 leaves position 12¼, no circuit is effective for relay 319 as before described.

When the called subscriber answers the current flowing through the winding of polarized relay 301 is reversed at the incoming selector and relay 301 operates. With relay 301 operated a circuit is now established from ground at the lower right contact of cam 632, lower left contact of cam 635, front contact of relay 301, normal contacts of relay 317, left contacts of cam 618, lower contact of interrupter 322 to battery through the winding of relay 302. Relay 302 upon operating locks over its inner upper front contact, the upper right contact of cam 604, the upper left contact of cam 618, normal contacts of relay 317, front contact of relay 301, lower left contact of cam 635, to ground at the lower right contact of cam 632. As soon thereafter as interrupter 322 closes its upper contact relay 323 operates over a circuit extending from battery, through its winding, the back contacts of relay 324, the lower left contact

of cam 602, the upper front contact of relay 302, upper contact of interrupter 322, left contacts of cam 618, thence as traced to ground over the front contact of relay 301. Relay 323 operates and locks through the winding of relay 324, its own front contacts to ground over the locking circuit of relay 302, and relay 324 operates in this locking circuit as soon as interrupter 322 opens its upper contact. Relay 324 upon operating establishes an obvious circuit for relay 321 which in this case locks over its inner lower front contact, the lower back contact of relay 319, upper left contact of cam 635 to ground at the lower right contact of cam 632. Since no operating circuit was established for relay 319 as in the case of a call to a distant area previously described, no charging for the call is effective until after the calling subscriber has hung his receiver upon the switchhook to release the connection.

When the calling subscriber hangs up to terminate the call and sequence switch 600 advances from position 14 into position 17 through the release of relays 616 and 351 a circuit is closed as sequence switch 600 passes through positions 15 to 17 for operating the calling line message register 105 which may be traced from battery, resistance 325, lower front contact of relay 321, lower contacts of cam 605, conductor 310, brush 381, terminal 380, conductor 114, right back contact of relay 101 to ground through message register magnet 105. As soon as sequence switch 600 leaves position 14, relay 302 releases and relays 323 and 324 also release. Until sequence switch 600 leaves position 15 relay 321 is held operated over its inner lower front contact the lower back contact of relay 319, the upper contact of cam 635, to ground at the lower right contacts of cam 632. With relay 302 released after sequence switch 600 leaves position 14, when sequence switch reaches position 15, relay 321 is held operated over its inner lower front contact, the back contact of relay 319, the upper back contact of relay 302, to ground at the lower right contact of cam 603 and is thus held operated until relay 302 again operates when sequence switch 600 reaches position 17. The message register is thus operated while sequence switch 600 passes from position 15 into position 17. The release of the connection then proceeds in the manner previously described. Thus for a call within the local area the calling subscriber is charged but once regardless of the length of the conversational period.

What is claimed is:

1. In an automatic telephone system, a calling line, a message register for said line, called subscribers' lines, a group of trunk circuits over which connections requiring a single charge may be extended, other groups of trunk circuits over which connections requiring multiple charges may be extended, means including a selector switch for extending a connection from said calling line over an idle trunk circuit in any desired one of said groups to a called line, means in said switch for controlling said message register, and means in said switch controlled in accordance with whether a trunk circuit of said first group or a trunk circuit of said other groups is selected and responsive to the response of a called subscriber for causing the operation of said register control means upon the termination of the connection or during the continuance of conversation.

2. In an automatic telephone system, a calling subscriber's line, a called subscriber's line, a trunk circuit, means including a selector switch for connecting said calling line to the called line over said trunk circuit, a source of current in said trunk circuit, relay means in said switch normally unresponsive to said source of current, means in said trunk circuit operative following the establishment of a connection to said called line for momentarily reversing said current for operating said relay means, and means operative upon the response of said called subscriber for again reversing said current to operate said relay means.

3. In an automatic telephone system, a calling subscriber's line, a called subscriber's line, a trunk circuit, means including a selector switch for connecting said calling line to the called line over said trunk circuit, a source of current in said trunk circuit, a relay in said switch normally unresponsive to said source of current, a first and a second means in said switch controlled by said relay, means in said trunk circuit operative following the establishment of a connection to said called line for momentarily reversing said current for operating said relay to operate said first means, and means operative upon the response of said called subscriber for again reversing said current to operate said relay for operating said second means.

4. In an automatic telephone system, a calling subscriber's line, a called subscriber's line, a trunk circuit, means including a selector switch for connecting said calling line to the called line over said trunk circuit, a message register for said calling line, a source of current in said trunk circuit, a first relay in said switch normally unresponsive to said source of current, a second relay operable by said first relay, means in said trunk circuit operative following the establishment of a connection to said called line for momentarily reversing said current for momentarily operating said first relay to thereby operate and lock said second relay, means in said switch for operating said register, means operative upon the response of said called subscriber for again reversing said current for operating said first relay, and circuit means controlled

by said first relay and said second relay for operating said message register operating means.

5. In a multi-office automatic telephone system, a calling subscriber's line, a message register for said calling line, a called subscriber's line terminating in a local office of said system, a local trunk circuit for extending a connection to said called line, a called subscriber's line terminating in a distant office of said system, an interoffice trunk circuit for extending a connection to said second called line, means including a selector switch for extending a connection from said calling line over either of said trunk circuits to said called lines, a source of current normally associated with each of said trunk circuits, relay means in said switch normally unresponsive to said source of current, means in said local trunk circuit operative upon the response of a local called subscriber for reversing said current to operate said relay, means controlled by said relay to operate said message register upon the termination of the connection, means in said interoffice trunk circuit operative following the establishment of a connection to a called line thereover for momentarily reversing said current source to momentarily operate said relay, means controlled by said relay for preparing said message register for operation, and means in said interoffice trunk operative upon the response of said called subscriber for again reversing said current to operate said message register.

6. In an automatic telephone system, a calling subscriber's line, a called subscriber's line, a trunk circuit, means including a selector switch for connecting said calling line to the called line over said trunk circuit, a source of current in said trunk circuit, relay means in said switch normally unresponsive to said source of current, means in said trunk circuit operative following the establishment of a connection to said called line for momentarily reversing said current for operating said relay means, and means in said trunk circuit operative upon the response of the called subscriber and until the connection is restored for periodically reversing said current to operate said relay means.

7. In an automatic telephone system, a calling subscriber's line, a message register for said line, called subscribers' lines, a group of trunk circuits over which connections requiring a single charge may be extended, other groups of trunk circuits over which connections requiring multiple charges may be extended, means including a selector switch for extending a connection from said calling line over an idle trunk circuit in any of said groups to a desired called line, means in said switch for controlling said message register, means in said switch controlled in accordance with whether a trunk circuit of said first group or a trunk circuit to said other groups is selected and responsive to the response of a called subscriber for causing the operation of said register control means upon the termination of said connection or during the continuance of conversation, and means in each of said multiple charge trunks for causing the periodic operation of said message register.

8. In an automatic telephone system a calling subscriber's line, a message register for said line, a called subscriber's line, means including a selector switch and a trunk circuit for extending a connection from said calling line to said called line, a first relay in said switch momentarily operable during the establishment of a talking connection through said switch, a source of current in said trunk circuit, a second relay in said switch, means in said trunk circuit operative following the establshment of a connection to said called line for causing said current to be momentarily reversed to operate said second relay, a third relay operable during the simultaneous operation of said first and second relays, means in said trunk circuit operative following the response of the called subscriber for reversing said current to reoperate said second relay, a message register operating relay in said switch, timing means including an interrupter and counting relays for operating said message register operating relay if said second relay remains operated for a predetermined period and said third relay is operated.

9. In an automatic telephone system, a calling subscriber's line, a message register for said calling line, a called subscriber's line, means including a selector switch and a trunk circuit for extending a connection from said calling line to said called line, a first relay in said switch momentarily operable during the establishment of a talking connection through said switch, a source of current in said trunk circuit, a second relay in said switch, means in said trunk circuit operative following the establishment of a connection to said called line for reversing said current to momentarily operate said second relay, a third relay operable during the simultaneous operation of said first and second relays, means in said trunk circuit operative following the response of said called subscriber for repeatedly reversing said current to reoperate said second relay, a message register operating relay in said switch, and timing means including an interrupter and counting relays for operating said message register operating relay each time the second relay operates for a predetermined period with said third relay operated.

10. In an automatic telephone system a calling line, a message register for said line, called subscribers' lines, a group of trunk circuits over which connections requiring a single charge may be extended, a group of trunk

circuits over which connections requiring multiple charges may be extended, a selector switch for extending a connection to called lines over said trunk circuit, a first relay in said switch momentarily operable during the establishment of a talking connection through said switch only if connection is made thereby to a trunk circuit of said second group, a source of current in each trunk circuit, a second relay in said switch, means in a trunk circuit of said second group operative following the establishment of a connection thereover for causing the current source of said trunk circuit to be momentarily reversed to operate said second relay, a third relay in said switch operable during the simultaneous operation of said first and second relays, means in each of said trunk circuits for reversing the current source thereof to operate said second relay once following the response of a called subscriber reached over a trunk circuit of said first group and a plurality of times during the conversational period following the response of a called subscriber reached over a trunk circuit of said second group, a message register operating relay in said switch, and means controlled by said second relay if said first relay is operated to operate said message register operating relay upon each operation of said second relay during the conversational period and once only when the calling subscriber hangs up if said first relay is not operated.

11. In an automatic telephone system, a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to the called line over said trunk circuit, means in said switch for controlling said message register, relay means in said switch for preparing said operating means for operation, means operative following the establishment of a connection to said called line for momentarily reversing said current source to operate said relay means, means operative upon the response of the called subscriber for again reversing said current source to operate said relay means, timing means in said switch controlled by said relay means for causing the operation of said message register operating means after a predetermined interval, and timing means in said trunk circuit for maintaining said current source reversed for an interval sufficient to permit said timing means in said switch to function.

12. In an automatic telephone system, a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to the called line over said trunk circuit, means in said switch for controlling said message register, relay means in said switch for preparing said operating means for operation, means operative following the establishment of a connection to said called line for momentarily reversing said current source to operate said relay means, means operative upon the response of the called subscriber for again reversing said current source to operate said relay means, timing means in said switch controlled by said relay means for causing the operation of said message register operating means after a predetermined interval, and timing means in said trunk circuit for periodically reversing said source of current for intervals sufficient to permit said timing means in said switch to function during each reversal.

13. In an automatic telephone system, a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to said called line over said trunk circuit, means in said switch for controlling said message register, relay means in said switch for preparing said operating means for operation, means operative following the establishment of a connection to said called line for momentarily reversing said current source to operate said relay means, and means in said trunk circuit including a timing switch, an interrupter and counting relays for periodically reversing said current source following the response of the called subscriber to repeatedly cause the operation of said message register operating means under the control of said relay means.

14. In an automatic telephone system a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to said called line over said trunk circuit, relay means in said switch for controlling said message register, a timing switch in said trunk circuit, means controlled by the response of the called subscriber for advancing said timing switch through a plurality of positions for reversing said current source a plurality of times to repeatedly operate said relay means, 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 relay means until said connection is released and means for changing the control of said timing switch over said relay means on all cycles subsequent to the initial cycle.

15. In an automatic telephone system a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to said called line over said trunk circuit, relay means in said switch for con-

trolling the message register, a timing switch in said trunk circuit, means controlled by the response of the called subscriber for advancing said timing switch through a plurality of positions for reversing said current source a plurality of times to repeatedly operate said relay means, 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 relay means until said connection is released, and means for changing the number of current reversals produced by said timing switch on all cycles subsequent to the initial cycle.

16. In an automatic telephone system a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to said called line over said trunk circuit, a timing switch in said trunk circuit, means controlled by the response of the called subscriber for advancing said timing switch through a plurality of positions for reversing said current source a plurality of times, means responsive to each such reversal for operating said message register, 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 reverse said current source for operating said message register until said connection is released and means for changing the number of current reversals produced by said timing switch during each cycle subsequent to the initial cycle.

17. In an automatic telephone system a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for conneting said calling line to said called line over said trunk circuit, a timing switch in said trunk circuit, means controlled by the response of the called subscriber for advancing said timing switch through a plurality of positions for reversing said current source a plurality of times, means responsive to each such reversal for operating said message register, 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 reverse said current source for operating said message register until said connection is released and means for reducing the number of current reversals produced by said timing switch during each cycle subsequent to the initial cycle.

18. In an automatic telephone system a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to said called line over said trunk circuit, a timing switch and counting relays in said trunk circuit, means controlled by the response of the called subscriber under the control of said counting relays for advancing said timing switch through a plurality of positions for reversing said current source a plurality of times, means responsive to each such reversal for operating said message register, 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 reverse said current source for operating said message register until said connection is released and means for changing the number of current reversals produced by said timing switch during each cycle subsequent to the initial cycle.

19. In an automatic telephone system a calling subscriber's line having a message register, a called subscriber's line, a trunk circuit having a source of current, means including a selector switch for connecting said calling line to said called line over said trunk circuit, a timing switch and counting relays in said trunk circuit, means controlled by the response of the called subscriber under the control of said counting relay for advancing said timing switch through a plurality of positions for reversing said current source a plurality of times, means controlled by said counting relays for measuring a predetermined period for each current reversal, means responsive to each such reversal for operating said message register, 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 reverse said current source for operating said message register until said connection is released, and means for changing the number of current reversals produced by said timing switch during each cycle subsequent to the initial cycle.

20. In an automatic telephone system a calling subscriber's line having a message register, a called subscriber's line, a group of trunk circuits over which connections requiring a single charge may be extended, other groups of trunk circuits over which connection requiring multiple charges may be extended, means including a selector switch for extending a connection from said calling line over an idle trunk circuit in any desired one of said groups to a called line, means in said switch for establishing a selective condition therein in accordance with whether a trunk of the first or second groups is selected, means in said switch for controlling said message register and means in said switch jointly con-

trolled from the trunk selected and in accordance with the selective condition established and responsive to the response of called subscriber for causing the operation of said register control means upon the termination of the connection or during the continuance of conversation.

In witness whereof, we hereunto subscribe our names this 18 day of August, 1930.

WARREN W. CARPENTER.
RAYMOND E. COLLIS.