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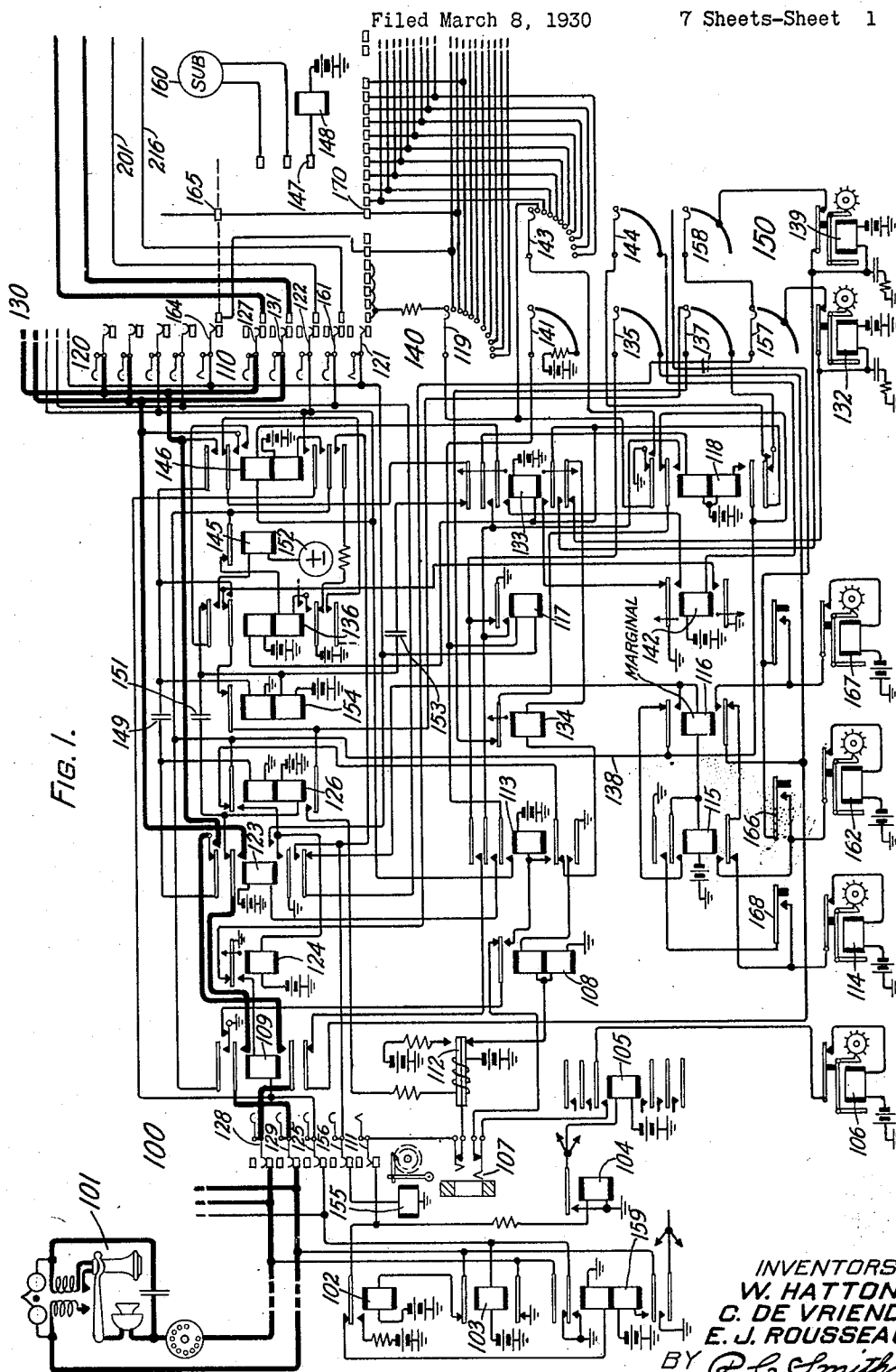
W. HATTON ET AL

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ZONE METERING TELEPHONE EXCHANGE SYSTEM

Filed March 8, 1930

7 Sheets-Sheet 1



INVENTORS
W. HATTON
C. DE VRIENDT
E. J. ROUSSEAU
BY *P. C. Smith*

ATTORNEY

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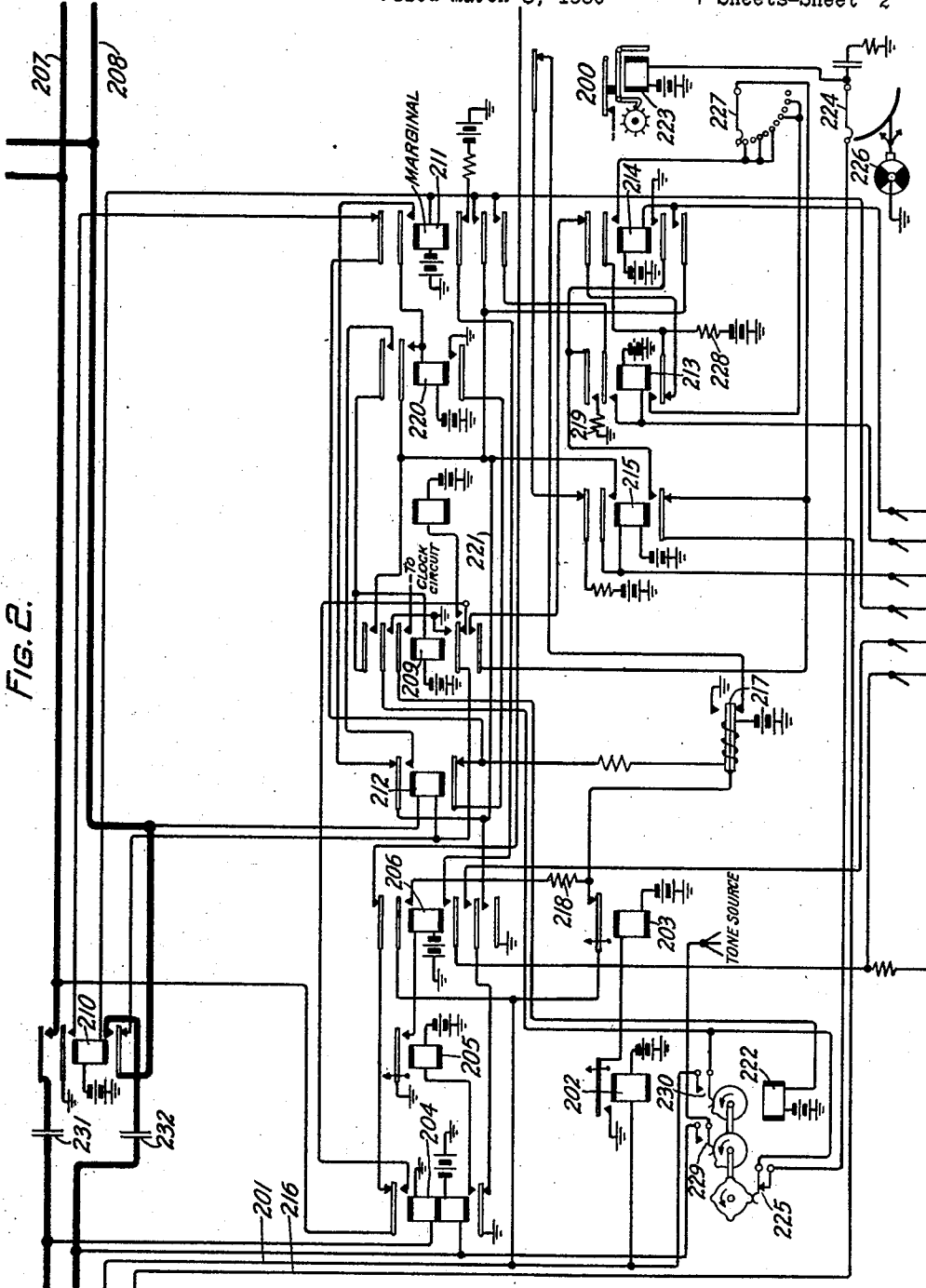
W. HATTON ET AL

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INVENTORS **W. HATTON**
C. DEVRIENDT
E. J. ROUSSEAU
BY *P. C. Smith*

ATTORNEY

Nov. 3, 1931.

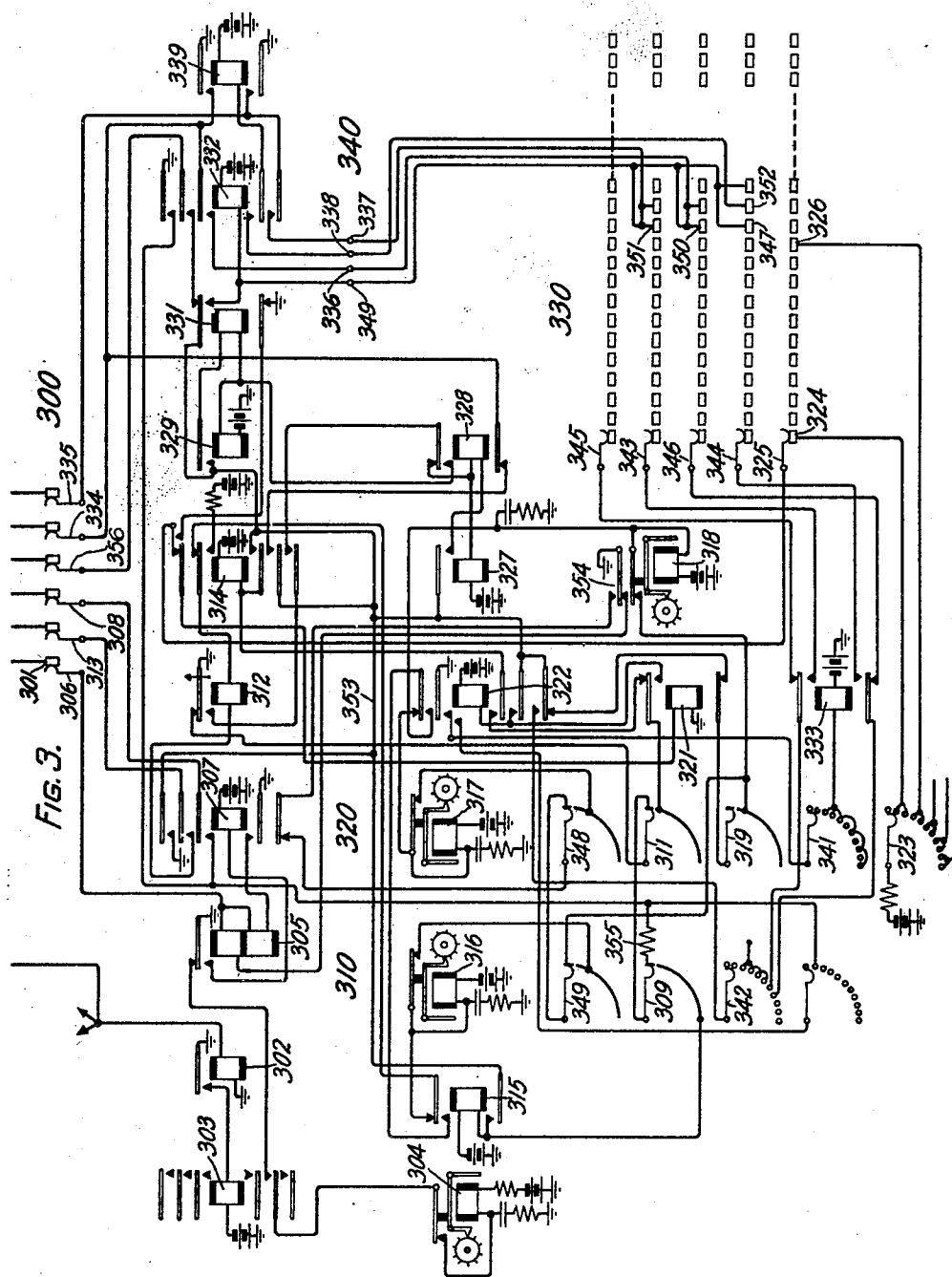
W. HATTON ET AL

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7 Sheets-Sheet 3



W. HATTON
G. DEVRIENDT
E. J. ROUSSEAU
INVENTORS
BY *P. C. Smith*

ATTORNEY

Nov. 3, 1931.

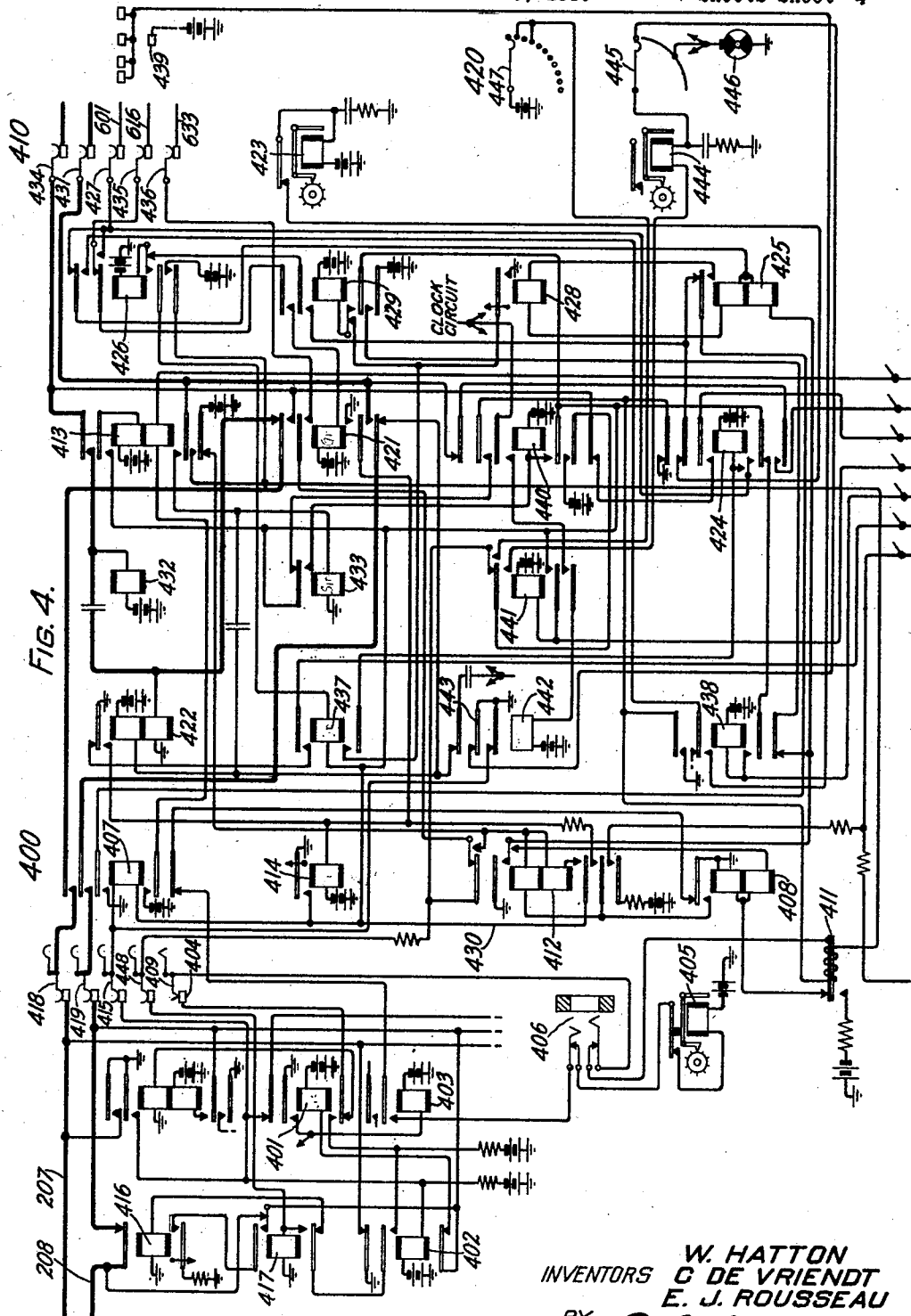
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W. HATTON
C. DE VRIENDT
E. J. ROUSSEAU
BY *P. C. Smith*

ATTORNEY

Nov. 3, 1931.

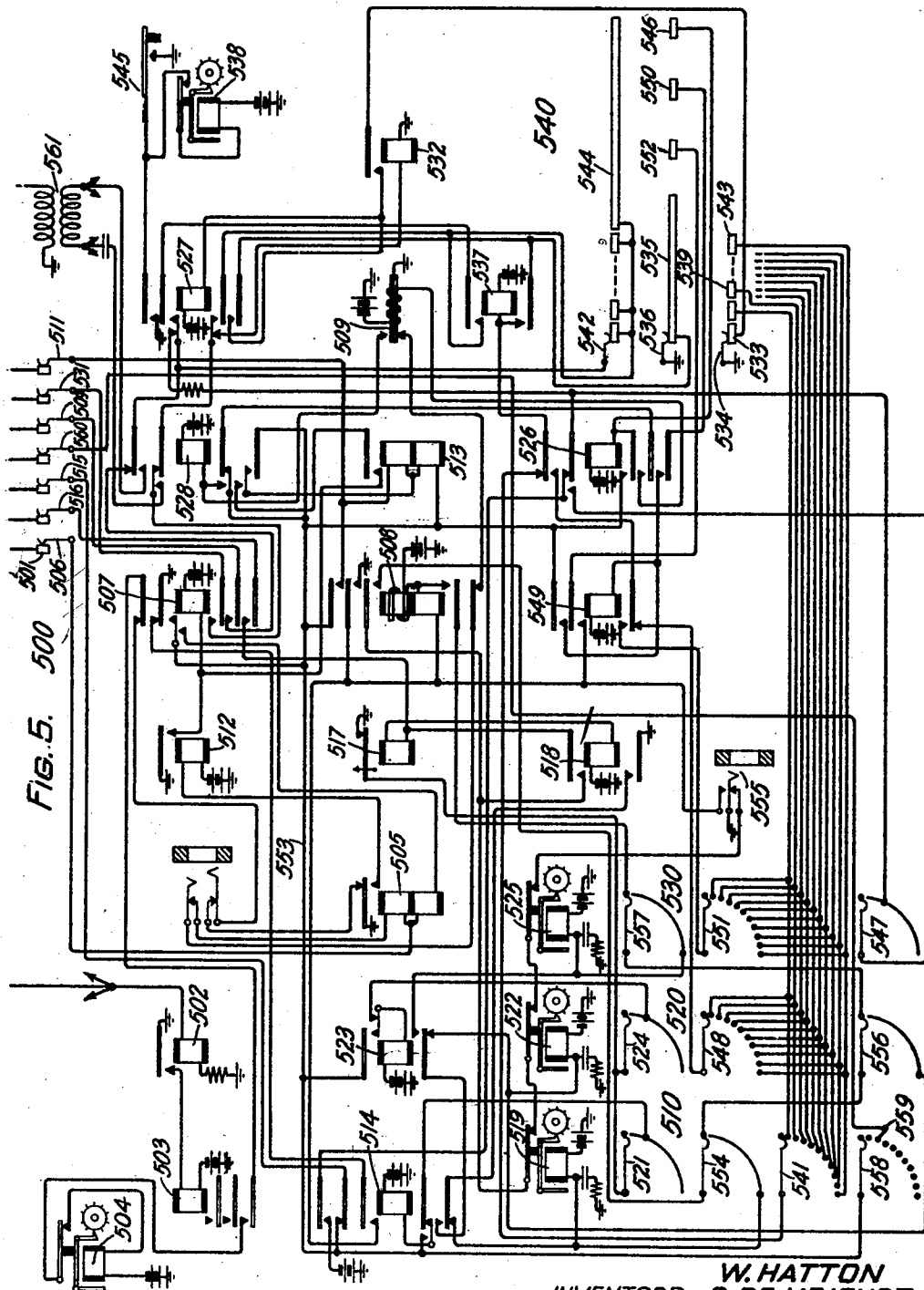
W. HATTON ET AL

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7 Sheets-Sheet 5



W. HATTON
INVENTORS
C. DE VRIENDT
E. J. ROUSSEAU
BY *P. C. Smith*

ATTORNEY

Nov. 3, 1931.

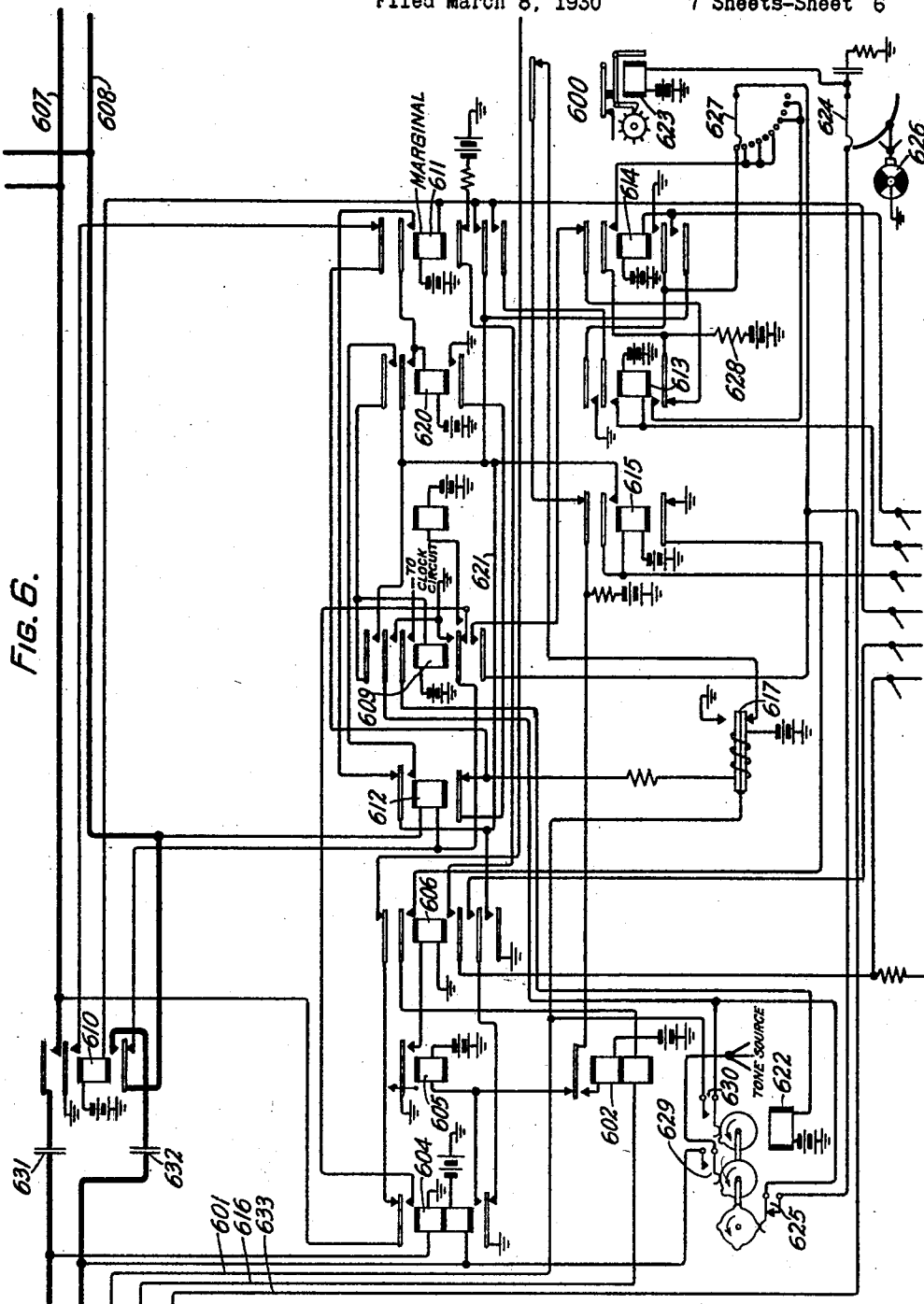
W. HATTON ET AL

1,829,799

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W. HATTON
INVENTORS C. DE VRIENDT
E. J. ROUSSEAU
BY *P. C. Smith*

ATTORNEY

Nov. 3, 1931.

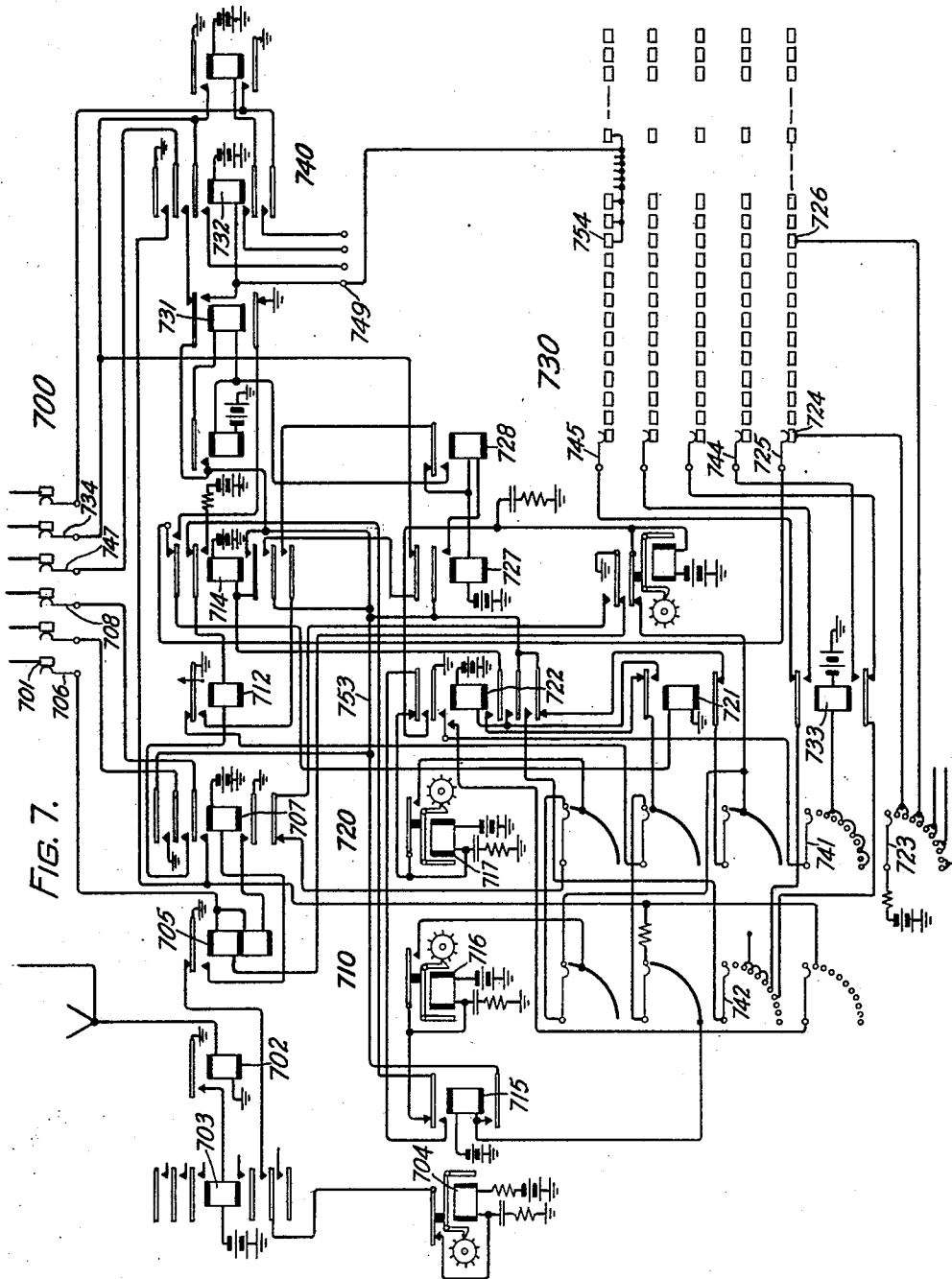
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7 Sheets-Sheet 7



W. HATTON
C. DE VRIENDT
E. J. ROUSSEAU
INVENTORS
BY *P. C. Smith*
ATTORNEY

UNITED STATES PATENT OFFICE

WILLIAM HATTON, CHARLES DE VRIENDT, AND ERNEST JEAN ROUSSEAU, OF PARIS, FRANCE, ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

ZONE METERING TELEPHONE EXCHANGE SYSTEM

Application filed March 8, 1930, Serial No. 434,216, and in Great Britain March 18, 1929.

This invention relates to automatic telephone systems, and more particularly to a rural exchange system comprising district offices grouped around a tandem office, the tandem office in turn being subsidiary to a central office. In such a system it is desirable that the charges for calls originated on lines either local to a district office or local to a tandem office be assessed in accordance with whether the call is to be terminated locally in either the district office or in the tandem office or is to be terminated outside of said offices. It is, therefore, the object of the invention to provide at each office of the system a discriminating device which is common to the trunk circuits outgoing from such office and which is capable of determining whether a call originated in such office is of a local or of an interoffice character and which will if the originating call is of the latter character cause the operation of the calling line message register in accordance with the zone of the exchange area in which the call is terminated.

The invention, one embodiment of which has been disclosed by way of example, is illustrated as embodying a district office which is subsidiary to a tandem office and which through the circuits of the tandem office may have access over the trunk circuits outgoing from the tandem office, to a central office. The district office is designed to have access to from 100 to 300 local subscribers' lines and to a group of trunk lines extending to the tandem office. It is provided with a plurality of link circuits, each link terminating at one end in a line finder and at the other end in a plurality of branches each having a group selector. Thus, if the office is designed for access to 200 lines certain of which are trunk lines extending to the tandem office, each link will terminate in two group selectors and if access is desired to 300 lines, each link circuit will terminate in three group selectors.

When a subscriber of the district office initiates a call all line finders of idle links having access thereto are started in search of the calling line and when one of the line finders finds the line it is seized thereby and

the finders of other links are stopped. Thereupon that one of the group selectors of the link taken for use which has access to outgoing trunks is started in search of an idle trunk. When an idle trunk becomes associated with the link circuit a discriminating registering device which is common to the group of trunks is associated with the trunk taken for use in readiness to record the first three digits to be dialed by the calling subscriber. Also, in response to the seizure of the outgoing trunk an idle link circuit at the tandem office which is also equipped with a line finder and group selector is started to find the trunk and to extend it over the group selector of the tandem office link to an idle trunk outgoing from the tandem office. When this latter trunk is seized a second discriminating registering device which is common to the group of trunks outgoing from the tandem office is associated with the selected trunk in readiness to record the first three digits to be dialed by the calling subscriber.

Upon the association of these registering devices with the established connection a dialing tone is transmitted to the calling line. The calling subscriber then proceeds to dial the first three digits of the wanted line number. If these digits are indicative that the calling subscriber desires connection with another subscriber's line which terminates at the same office, a discriminating signal is sent to the link circuit of the district office from the registering device of that office. This signal determines whether the wanted line may be reached over the terminal bank of the same group selector over which access was had to the outgoing trunks or whether it may be reached over one of the other parallelly connected group selectors, and renders marking registers effective in the link circuit for recording the remaining digits of the line designation dialed by the calling subscriber. In accordance with the setting of the marking registers the group selector which has been made effective by the discriminating signal is thereupon operated to select the wanted line and to release the connection over the outgoing trunk previously established through the tandem office and

to release the associated discriminating devices at both the district and tandem offices. Upon the termination of the call the calling subscriber is charged by apparatus associated with the district link circuit on the basis of a successful local call.

If, however, the digits recorded in the discriminating registering devices of the district and tandem offices indicated that the call was of a character to be terminated in or beyond the tandem office, then the connection established upon the initiation of the call to the tandem office is not released and the discriminating registering device of the district office proceeds to set up on registering relays of the outgoing trunk with which it is at the time associated a zone registration in accordance with the office designation registered on the registers of said registering device. These zone relays are instrumental upon the successful completion of the connection for variably operating the message register of the calling line.

There is also associated with the zone relays of the trunk circuit an overtime charging mechanism which causes the periodic operation of the calling line message register through a predetermined maximum period of conversation. In the circuits illustrated this overtime charging mechanism functions to operate the message register at three-minute intervals over a period of twelve minutes and then causes the peremptory release of the connection if the calling subscriber has not prior to the expiration of that period released the connection.

Similarly, if a call is originated on a subscriber's line terminating in the tandem office all line finders of idle links of the tandem office having access thereto are started in search of such line and when one of the line finders finds the calling line, such line is seized and the finders of other links are stopped. Thereupon the group selector in which the other end of the link circuit terminates is operated to connect with an idle trunk outgoing from the tandem office and a discriminating registering device is associated with such trunk in readiness to record the first three digits dialed by the calling subscriber. If the first three digits dialed by the calling subscriber indicate that the calling subscriber desires a connection with another subscriber's line which terminates in the tandem office, a signal is sent back to the tandem office link, which causes the release of the outgoing trunk circuit and associated registering device and apparatus is rendered effective in the tandem office to complete the call therein in response to the remaining digits dialed by the calling subscriber.

If, however, the digits recorded in the registering device indicate that the call is of a character to be terminated beyond the tan-

dem office, then the trunk is not released and the registering device of the tandem office proceeds to set up on the registering relays of the outgoing trunk a zone registration in accordance with the office designation registered on the registers of such registering device. These zone relays are instrumental upon the successful completion of the connection for variably operating the message register of the calling line. Provision is also made to charge for the call periodically during a predetermined period and to peremptorily release the connection at the expiration of that period if the calling subscriber has not terminated the call.

From the foregoing brief description of the invention it will be apparent that for a call originated in any office which is of an interoffice character charging on an overtime bases in accordance with the zone of the exchange in which the call is to be terminated is controlled by the apparatus in the office of origin and associated with the interoffice trunk outgoing therefrom over which the call is extended.

Referring to the drawings, Fig. 1 shows at the left a subscriber's line, one of the link circuits of the community or district office terminating at one end in a line finder and at the other end in a plurality of parallelly connected group selectors, tens and units marking switches for controlling the settings of the group selectors and at the right one outgoing trunk circuit and a subscriber's line terminating in the bank of one of the group selectors.

Fig. 2 shows the apparatus associated with the outgoing end of the trunk circuit and in the lower right portion of the figure a message register impulsing switch for controlling the calling line message register of Fig. 1 in accordance with the zone of the exchange into which a connection is extended.

Fig. 3 shows a discriminating registering device for recording and translating the first three digits dialed by a calling subscriber together with a trunk finder switch, shown in the upper portion of the figure, whereby the registering device may be associated with any one of a group of trunk circuits.

Fig. 4 shows at the left the incoming end of the two-way trunk circuit shown in Fig. 2, one of the link circuits of the tandem office terminating at one end in a line finder having access to both incoming trunk circuits and subscribers' lines and at the other end in a group finder having access to outgoing trunks such as shown in Fig. 6 and to local third group finders (not shown).

Fig. 5 shows a tandem register sender for controlling the establishment of connections to subscribers' lines terminating in the tandem office and a link finder individual thereto for associating it with a tandem link circuit.

Fig. 6 shows an outgoing trunk circuit

and in the lower right portion of the figure a message register impulsing switch for controlling the message registers of calling lines which are local to the tandem office.

Fig. 7 shows a discriminating registering device for recording and translating the first three digits dialed by a calling subscriber in either the district office of Fig. 1 or in the tandem office, together with a trunk finder switch individual thereto, whereby the registering device may be associated with any one of the outgoing trunk circuits such as the trunk circuit shown in Fig. 6.

For a complete disclosure of the invention Fig. 2 should be placed at the right of Fig. 1, Fig. 3 beneath Fig. 2, Figs. 4 and 5 at the right of Figs. 2 and 3, respectively, and Figs. 6 and 7 at the right of Figs. 4 and 5, respectively.

All of the switches disclosed are of the single motion step-by-step type. The line finders 100 and 400 of Figs. 1 and 4 are of the type having no normal position and each is equipped with two sets of wipers placed on the switch shaft 180° apart. The group selectors 110, 120 and 130 of Fig. 1 are of the same general type as the line finders and each has access to one hundred sets of bank terminals. The group selector 110 has access to a group of five outgoing trunks and to ninety subscribers' lines and the other two group selectors 120 and 130, the wipers of selector 130 not being illustrated, each have access to one hundred subscribers' lines. The group selector 410 of Fig. 4 is of the hunting type. The marking switches 140, 150, the registers 310, 320, 510, 520, 530, 710 and 720 and the message register impulsing switches 200, 420 and 600 are all minor type switches. The translator switches 330, 540 and 730 each have access to fifty sets of bank terminals, the terminals of the upper four levels of switch 330 being cross-connected, as may be desired, to the cross-connecting frame 340 for controlling metering for establishing local connections, and the upper four levels of switch 730 being cross-connected, as may be desired to cross-connecting frame 740 for controlling metering. The trunk finding switches 300, 500 and 700 have no normal positions.

Initiation of a call in district office

For a better understanding of the invention reference may be had to the following description in which the progress of a call from the calling line 101 over the circuits of Figs. 1 to 7 inclusive, will first be described in detail. When the calling subscriber moves his receiver from the switchhook a circuit is established from battery, through the winding of line relay 102, the upper back contact of cut-off relay 103, over the loop of the calling line to ground at the lower contact of relay 103. Relay 102 upon operating

establishes an obvious circuit for the common group relay 104 which in turn establishes a circuit for the common line finder start relay 105. Relay 105 at its front contacts closes start circuits for the stepping magnets of all idle line finders having access to the group of lines in which the calling line is located. It will be assumed that the line finder 100 is that one of these line finders which is to be used in establishing the connection. The circuit for starting this line finder may be traced from battery, through the magnet winding and interrupter contacts of stepping magnet 106, contacts of relay 105, contacts of test jack 107, back contact of relay 108 to ground at the upper normal contacts of relay 109.

In response to the operation of magnet 106 the wipers of the line finder are advanced until the test wiper 111 engages the test terminal of the calling line. Then a circuit is established from ground, through the lower winding of relay 108, the normal contact of thermostatic relay 112, contacts of jack 107, wiper 111 to battery at the front contact of relay 102. Relay 108 upon energizing closes an obvious circuit for relay 113 and opens at its back contact the circuit of stepping magnet 106. With relay 113 operated, ground is connected over the lower contact of relay 113 and the upper winding of relay 108 to test wiper 111 to prevent the seizure of the calling line by other line finders and a circuit is closed for the stepping magnet 114 of the group selector 110 to advance this group selector to hunt for an idle outgoing trunk. This circuit extends from battery, through the winding and interrupter contacts of magnet 114, lower back contacts of relays 115 and 116, lower back contact of relay 109, upper contact of relay 113 to ground at the back contact of test relay 117. When an idle trunk is found, relay 117 operates in a circuit extending from ground at the upper normal contact of relay 118, wiper 119 of marking switch 140 and its normal terminal, strapped terminals with which wiper 121 of the group selector engages, winding of relay 117, inner upper front contact of relay 113, wiper 122, conductor 201 to battery through the winding of relay 202. Relay 202 also operates in this circuit and performs a function which will be described later.

Relay 117 upon operating, opens the circuit of magnet 114 to arrest the operation of the group selector 110 and establishes over its front contact and a contact of relay 113 a circuit for relay 123. At its inner lower front contact relay 123 applies direct ground through the winding of relay 117 over wiper 122 to conductor 201 to mark the selected trunk busy and closes an obvious circuit for relay 124. Relay 124 upon operating establishes a circuit from ground through the winding of relay 109, over wiper 125 of line

finder 100 to battery through the calling line cut-off relay 103. Relay 103 disconnects the line relay 102 which in turn releases relay 108 and if there are at the time no other lines calling in the group, releases common relays 104 and 105 thereby arresting the operation of any other idle line finders that may have been started. After the release of relay 108, relay 113 is locked over its inner lower front contact, the back contact of relay 126 to ground at the upper front contact of relay 109.

Relay 202 of the link circuit which operated in series with test relay 117 upon operating establishes an obvious circuit for relay 203. With relay 109 operated a circuit is established from ground, through the upper winding of relay 204, wiper 127 of selector 110, upper alternate contacts of relay 123, lower front contact of relay 109, wiper 128, over the calling line, back over wiper 129, the inner upper contact of relay 109, the inner upper front contact of relay 123, wiper 131 to battery through the lower winding of relay 204. Relay 204 operates in this circuit and closes an obvious circuit for slow to release relay 205 which operates in turn and causes the operation of relay 206. A circuit is now extended over the outgoing conductors 207 and 208 of the trunk circuit to the tandem office of Figs. 4 to 7, inclusive to which the community office is subsidiary, this circuit extending from battery, through the winding of relay 401, the lower back contact of relay 402 over conductor 208, the back contact of relay 210, the lower back contact of relay 209, upper front contact of relay 204, conductor 207 to ground at the upper back contact of relay 402. Relay 401 operates in this circuit and at its upper front contact closes an obvious circuit for common start relay 403 and at its lower front contact connects battery potential to the test terminal 404 to mark the trunk 207, 208 as calling. Relay 403 upon operating closes start circuits for all idle line finders such as 400, which have access to the group of trunk circuits in which the calling line is located.

It will be assumed that the line finder 400 is to be used to extend the connection and that the start circuit for magnet 405 extends from battery through the winding and interrupter contacts of magnet 405, contacts of test jack 406, contacts of relay 403, back contact of relay 407 to ground at the back contact of test relay 408. When the wipers of the line finder engage the terminals of the calling trunk circuit test relay 408 operates in a circuit extending from battery on terminal 404, wiper 409, contacts of jack 406, normal contacts of thermostatic relay 411 to ground through the upper winding of relay 408. Relay 408 operates, opening the circuit of magnet 405 to arrest further motion of line finder 400 and closes a circuit for op-

erating relay 412 extending from ground at the front contact of relay 408, upper winding of relay 412 to battery at the back contact of relay 413. At its inner upper front contact relay 412 connects ground through the lower low resistance winding of relay 408 to the test wiper 409 to mark the terminals of the calling trunk against seizure by another line finder and at its intermediate lower front contact establishes a circuit for operating relay 414 extending from battery through the winding of relay 414, the contact of relay 412 to ground at the front contact of relay 408. At its contact relay 414 establishes a circuit extending from ground through the winding of relay 407, wiper 415 to battery, through the winding of cut-off relay 402. Relay 402 disconnects the line relay 401 from the trunk circuit, which upon releasing opens the circuit of common start relay 403 to stop all other line finders which may have been started, provided that there are at the time no other trunks of the group or subscribers' lines calling. Relay 402 also closes an operating circuit for slow-to-release relay 416 extending from ground through the winding of relay 416, lower back contact of relay 417, front contact of relay 402 to battery. Relay 416 opens the trunk conductor 208 at its back contact, but this opening is at the time ineffective since a shunt of the contacts of relay 416 exists over the upper normal contacts of relay 417.

Relay 407 upon operating extends the trunk conductor 207 over line finder wiper 418, the upper front contact of relay 407, the upper back contact of relay 421 to ground through the lower winding of relay 422 and at its intermediate upper front contact extends conductor 208 over wiper 419, the lower back contact of relay 421 to battery through the upper winding of relay 422. At its lower front contact relay 412 connects marking potential to test terminals 501 of all link finders similar to finder 500 of Fig. 5 and in parallel to ground through start relay 502. Relay 502 operates, closing an obvious circuit for relay 503 which in turn establishes operating circuits for the stepping magnets of all idle link finders individual to idle tandem senders. One of these senders is shown in Fig. 5 and it will be assumed that this sender is idle and becomes connected with the link of Fig. 4. The operating circuit of finder 500 may be traced from battery through the winding and interrupter contacts of magnet 504, contact of relay 503, upper back contact of relay 507 to ground at the back contact of relay 505. When the calling link circuit is found, test wiper 506 of finder 500 engages terminal 501, and the circuit previously traced to terminal 501 is extended over wiper 506, the upper winding of test relay 505, the lower back contact of relay 508 to ground at the normal contact of thermostatic relay 130

509. Relay 505 thereupon operates, opening at its back contact the circuit of magnet 504 and closing an obvious circuit for relay 512 which in turn closes an obvious circuit for relay 507. Relay 507 at its inner upper front contact now connects ground through the lower low resistance winding of relay 505 to test terminal 501 and at its upper back contact opens another point in the circuit of magnet 504. At its inner upper front contact relay 507 connects ground to conductor 553 for supplying locking ground for relays of the sender and at its lower front contacts prepares circuits from wipers of finder 500. At its lower front contact relay 407 also establishes a circuit extending through the lower winding of relay 413, wiper 511 of link finder 500, both windings of relay 513 to ground on conductor 553. Relay 513 operates but performs no useful function at this time. Relay 413 does not operate due to the resistance of the windings of relay 513.

When relay 407 operated a circuit was established for starting the group selector such as is shown in Fig. 6, which circuit may be traced from battery through the winding and interrupter contacts of magnet 423, intermediate upper back contact of relay 424, back contact of relay 425 to ground at the inner upper front contact of relay 407. When an idle outgoing trunk is found, for example, the trunk shown in Fig. 6, relay 425 operates in a circuit extending from ground on the inner upper front contact of relay 412, lower winding of relay 425, upper back contact of relay 426, test wiper 427, conductor 601, normal contact of thermostatic relay 617 to battery at the upper back contact of relay 615 and to battery over the back contact of relay 602 through the winding of relay 605. Relays 425 and 605 operate, relay 425 upon operating locking from battery on test wiper 427 over its upper winding through the winding of relay 428, the front contact of relay 425 to ground at the inner upper front contact of relay 407 and opening at its back contact the circuit of magnet 423 to arrest the further hunting movement of the group selector. At its contact relay 428 closes an obvious circuit for relay 429 which operates and locks over its inner lower front contact to ground placed on conductor 430 over the front contact of relay 414. Relay 605 upon operating closes an obvious circuit for relay 606.

Relay 602 now operates in a circuit extending from ground at the lower back contact of relay 615, upper front contact of relay 606, lower winding of relay 602, conductor 616, wiper 435, inner upper normal contacts of relay 426, upper front contact of relay 429 to battery through the winding of relay 421. Relays 602 and 421 operate, relay 602 connecting battery through its upper winding

and front contact in parallel with battery through resistance over the upper back contact of relay 615 to conductor 601 to mark the trunk busy to other tandem link group selectors and relay 421 disconnecting the windings of relay 422 from the incoming dialing loop and extending this loop over its upper and lower front contacts directly to the windings of relay 604. At its inner lower front contact relay 421 establishes a new holding circuit for holding relay 414 operated after the release of relay 422. Relay 604 now operates establishing a new operating circuit for relay 605 which in turn holds relay 606 operated.

Returning to the trunk circuit of Fig. 2, relay 206 upon operating at its inner upper contact connects busy potential from the upper back contact of relay 215 over the normal contacts of thermostatic relay 217, resistance 218, contacts of relay 206 to conductor 201 in parallel with relay 202 for holding relay 117 of the district link circuit operated. At its innermost lower front contact relay 206 connects marking potential over the lower back contact of relay 211, the inner lower front contact of relay 206 to test terminals 301 of all trunk finders similar to trunk finder 300 of Fig. 3 and in parallel to ground through start relay 302. Relay 302 operates closing an obvious circuit for relay 303 which in turn establishes operating circuits for the stepping magnets of all idle trunk finders individual to idle registering devices. One of these registering devices is shown in Fig. 3 and it will be assumed that this registering device is idle and becomes connected with the trunk of Fig. 2. The operating circuit of trunk finder 300 of this registering device may be traced from battery, through the winding and interrupter contacts of stepping magnet 304, a contact of relay 303 to ground at the back contact of relay 305. When the calling trunk is found and test wiper 306 of trunk finder 300 engages terminal 301, the circuit previously traced to terminal 301 is extended over wiper 306, the upper winding of relay 305 to ground at the normally closed contact of the off-normal springs 354 of translator switch 330. Relay 305 thereupon operates opening the circuit of magnet 304 and closes an obvious circuit for relay 307 which at its lower front contact connects the low resistance winding of relay 305 into circuit with wiper 306 to busy the trunk circuit to other trunk finder switches.

Relay 307 also closes a circuit in parallel through the windings of relays 210 and 211 over wiper 308, the innermost upper front contact of relay 307, resistance 355, normal terminal and wiper 309 of register 310, normal terminal and wiper 311 of register 320 to ground at the back contact of relay 312. Relay 210 operates to close the outgoing

trunk circuit so that the subscriber may receive a dial tone incoming over the trunk circuit. Relay 211 being marginal does not, however, operate at this time because of the resistance 355 in its operating circuit. The continuity of the loop circuit over the outgoing trunk circuit is not, however, broken by the operation of relay 210 since it is maintained through the winding of supervisory relay 212.

Following the seizure of the trunk circuit of Fig. 6 it functions in identically the same manner as just described in connection with Fig. 2 to cause the association therewith of the discriminating registering device of Fig. 7 and to establish an out-dialing loop over conductors 607 and 608 under the control of impulse repeating relay 604. This dialing loop may, for example, extend to a central office to which the tandem office is subsidiary. Upon the connection of the registering device of Fig. 7 relay 610 operates in the same manner as relay 210 and extends trunk conductors 607 and 608 over its front contacts through condensers 631 and 632, the wipers 434 and 431, front contacts of relays 421 and 407, wipers 418 and 419, trunk conductors 207 and 208, front contacts of relay 210, condensers 231 and 232, wipers 127 and 131, thence as traced to the calling line. A dialing tone is transmitted over this circuit when apparatus associated with the distant end of trunk 607, 608 is ready to receive impulses.

Establishment of a call local to the district office

When the calling subscriber receives this dialing tone he proceeds to dial the digits of the wanted line number. It will be assumed that the number of the wanted line is 74125, indicative of a line which may be reached locally over the wipers of the group selector 110 of Fig. 1. In response to dialing the first digit seven, the impulsing relay 204 of the trunk circuit of Fig. 2 releases for each impulse thereby repeating the impulses through the winding of relay 312 in a circuit extending from ground at the lower back contact of relay 204, the intermediate lower front contact of relay 206, wiper 313, the upper intermediate front contact of relay 307, winding of relay 312, inner upper back contact of relay 314, back contact of relay 315 to battery through the winding of stepping magnet 316 of the register 310. Relay 312 operates in this circuit and being slow to release remains energized during the transmission of the series of impulses and at its back contact opens the previously traced circuit of relay 210 which thereupon deenergizes and shunts the winding of relay 212 from the outgoing trunk dialing loop for permitting the better repetition of impulses over the outgoing trunk circuit. At its upper contacts relay 204 repeats impulses over

the outgoing trunk circuit 207, 208 thereby operating impulse repeating relay 604. Relay 604 in turn repeats impulses out over trunk conductors 607, 608 and repeats impulses to the stepping magnet 716 of register 710 of Fig. 7. The first digit dialed thus sets the registers 310 and 710 into their seventh positions. Upon the termination of the impulses relay 312 releases and closes a circuit for relay 315 extending from battery, winding of relay 315, off-normal terminals and wiper 309 of register 310, normal terminal and wiper 311 of register 320 to ground at the back contact of relay 312. Relay 315 energizes and locks over its lower contact to ground applied to conductor 353 at the upper front contact of relay 307, and switches the impulsing circuit previously traced from the winding of magnet 316 of register 310 over the upper back contact of relay 322 to the winding of magnet 317 of register 320. Similarly relays 712 and 715 function to prepare the registering device of Fig. 7 to register the second series of impulses upon its register 720.

The second digit four dialed by the calling subscriber now sets the register 320 to its fourth terminal position. Immediately the second digit register 320 moves off normal, the rotation of translator switch 330 is started by a circuit extending from battery, through the winding and interrupter contacts of magnet 318, the off-normal terminals and wiper 319, lower back contact of relay 321, lower back contact of relay 322 to ground on conductor 353. The terminals in the lowermost bank of register 320 are connected in pairs 1, 2; 3, 4; etc., and are connected by jumpers to terminals 1, 11, 21, etc., in the marking level of the translator switch 330. The translator switch hunts for the marked terminal under the control of test relay 321, but if the first terminal is marked the switch does not move since relay 321 will operate immediately when register 320 leaves normal over a circuit extending from battery, wiper 323, No. 1 terminal and wiper 325 of translator switch 330, upper normal contacts of relay 314 to ground through the winding of relay 321. When the marked terminal 326 is found, relay 321 operates over the circuit just traced, opening the circuit of stepping magnet 318. When the relay 312 again deenergizes upon the termination of the second series of impulses, with relay 321 operated a circuit is closed for relay 322 extending from battery, winding of relay 322, front contact of relay 321, off-normal terminals and wiper 311 of register 320 to ground at the back contact of relay 312. Relay 322 operates and locks to ground on conductor 353. Similar operations are performed simultaneously in the registering device of Fig. 7.

In response to the dialing of the third digit one an impulse is repeated by the impulsing

relay 204 as before traced through the winding of relay 312, thence over the upper front contact of relay 315, the upper front contact of relay 322 to battery from the winding of stepping magnet 318. It was assumed that the third digit was one and therefore the translator wipers are advanced one step further. As soon as wiper 325 leaves terminal 326, the circuit of relay 321 is opened. When relay 312 again deenergizes upon the termination of the third digit series of impulses a circuit is established for relay 314 extending from battery through the winding of relay 314, inner lower front contact of relay 322, back contact of relay 321, thence as traced to ground at the back contact of relay 312. Relay 314 upon operating locks over its inner lower front contact to ground on conductor 353. The registering device of Fig. 7 is similarly operated.

The terminals of the four upper levels of translator switch 330 are multiplied in accordance with the size of the various offices of the exchange and are jumpered to the points 336, 337 and 338 in accordance with the distance between the originating office and the other offices. It will be noted that the even numbered terminals of the bank associated with wiper 341 are multiplied to the wiper switching relay 333 and that as the second digit dialed was four, or of even value, relay 333 is operated over wiper 341 and the inner upper front contact of relay 322. In addition the sixth and seventh terminals in the bank of register 310 to which wiper 342 has access are connected to the armatures of relay 333 and in accordance with the energized or deenergized condition of this relay, are connected to either wipers 343 and 344, or 345 and 346 of the translator switch. Since it has been assumed that the register 310 was set into its seventh terminal position and that relay 333 is operated, wiper 344 only is connected in a circuit over wiper 342, the lower front contact of relay 322 to ground on conductor 353. Since also the translator has been advanced to position its wiper 344 upon terminal 347, this circuit is extended by a jumper to cross-connection point 349 and thence to battery through the winding of relay 332 as soon as relay 322 operates following the termination of the third digit series. Relay 332 upon operating now establishes a circuit for relay 215 extending over wiper 356, the intermediate upper contact of relay 332, back contact of relay 331 to ground on conductor 353. At its upper front contact relay 332 closes a circuit extending from ground, over the inner upper front contact of relay 307, wiper 308 to battery through the windings of relays 210 and 211, thereby causing the operation of these relays. It having been assumed that connection is to be made with the line of a local subscriber which may be reached over the wipers of group selector 110,

no cross-connection is made between terminal 347 and the cross-connection points 336, 337 and 338 and therefore relays 213, 214 and 339 are not operated at this time and no discriminating signal is therefore sent to the district link circuit over conductor 216 upon the operation of relay 215.

At the registering device of Fig. 7 the registers 710 and 720 have been set in accordance with the first two digits dialed and the translator is set in the same manner as described more in detail in connection with the setting of the registering device of Fig. 3. Since each tandem group is allotted 1000 lines, it is known after the first two digits have been received whether the call is local to the tandem group. If the call is not local, a circuit is established following the operation of relay 714 which may be traced from battery through the winding of relay 613, wiper 734, back contact of relay 727, intermediate lower front contact of relay 714 to ground over conductor 753 and the upper front contact of relay 707. Relay 613 upon operating closes a circuit at its upper front contact from ground over the normal terminal and wiper 627 of meter impulsing switch 600, conductor 633, wiper 436, the inner upper front contact of relay 421, the upper alternate contacts of relay 412 to the winding of relay 412, thereby shunting relay 412 and causing its deenergization. Relay 412 thereupon removes battery from the test terminal 501 releasing relay 505 and thereby releasing the register sender of Fig. 5.

At its upper back contact, relay 215 disconnects battery potential from conductor 201, thereby releasing relay 117 in the link circuit, in turn releasing relay 123. The release of relay 123 in turn opens the circuit of relay 204 in the trunk circuit of Fig. 2, releasing relays 205 and 206 and relays 305 and 307 of the register circuit of Fig. 3. The release of relay 307 removes holding ground from conductor 353, thereby releasing operated relays 314, 315, 322 and 332 and in turn releasing relays 333 and 215. A circuit is now established for restoring the register 320 extending from battery, through the winding and interrupter contacts of magnet 317, off-normal terminals and wiper 348 of register 320, back contact of relay 307 to ground at the off-normal contacts 354 of translator switch 330. When the register 320 reaches normal the operating circuit for magnet 316 of register 310 is established from battery, through the winding and interrupter contacts of magnet 316, wiper 349 and the off-normal terminals of the bank with which it cooperates, the normal terminal and wiper 348 of register 320, thence to ground as traced to off-normal contacts 354. When the register 310 reaches normal the operating circuit of magnet 318 of translator switch 330 is established from battery through the winding

and interrupter contacts of magnet 318, the normal terminal and wiper 349 of register 310, thence as traced to ground. Its restoring circuit is opened when the translator reaches normal and opens contacts 354. Trunk finder 300 has no normal position and remains in contact with the terminals of the trunk circuit last used. All apparatus of the trunk circuit of Fig. 2 and register of Fig. 3 is now in normal condition.

Upon the release of relay 204 the circuit previously traced through the windings of relay 604 is opened, whereupon this relay releases, in turn releasing relays 605 and 606 of the trunk circuit of Fig. 6 and relay 705 and 707 of the registering device of Fig. 7. The release of relay 707 initiates the release of all operated apparatus of this registering device in the same manner as previously described in connection with Fig. 3. Relay 606 upon releasing also opens the circuit previously traced for relay 421 and this relay releases, removing holding ground from the winding of relay 414. Also relay 422 is again connected to the incoming trunk conductors 207 and 208 by the release of relay 421 which does not operate at this time since these trunk conductors have been opened at the district link circuit. Therefore there being no holding circuit effective for relay 414, it releases, removing holding ground from conductor 430 and thereby releasing all operated relays of the tandem link circuit. Line finder 400 and group selector 410 being of the non-housing type remain in their operated positions.

At the district link circuit of Fig. 1 upon the release of relay 123 the windings of relay 126 are connected to the calling line loop over the contacts of relay 109 before slow to release relay 124 has had time to release following the release of relay 123, and a new holding circuit for relay 124 is therefore established over the upper front contact of relay 126 to ground over conductor 138 and the upper front contact of relay 109. When the calling subscriber now dials the tens digit which was assumed to be two, relay 126 releases for each impulse and establishes a circuit for the tens marking switch magnet 132 which extends from battery, through the winding of magnet 132, lower back contact of relay 133, winding of relay 134, back contact of relay 113 which released upon the operation of relay 126, back contact of relay 126 to ground on conductor 138. Slow to release relay 134 operates in series with magnet 132 and remains operated until the tens series of impulses terminates.

As soon as the marking switch 140 leaves normal the group selector 110 starts hunting by reason of a circuit for its stepping magnet extending from battery, through the winding of magnet 114, lower back contacts of relays 115 and 116, off-normal terminals

and wiper 135 of marking switch 140 to ground at the back contact of relay 117. When the impulses of the tens digit have been completely transmitted relay 134 releases and a circuit is established in parallel from battery, through the upper winding of relay 136 and the winding of relay 133, over the lower normal contacts of relay 118, wiper 137 and off-normal terminals of switch 140, back contact of relay 134, inner upper back contact of relay 118 to off-normal ground on conductor 138. Relay 133 locks itself operated over its inner lower front contact to ground at the back contact of relay 142 and changes the impulsing circuit controlled by relay 126 from the winding of magnet 132 to the winding of magnet 139 of units marking switch 150 which is now set in response to the dialing of the units digit five. Relay 136 locks over its locking contact and lower winding and back contact of relay 145 to off-normal ground on conductor 138.

When the group selector 110 reaches the terminal 142 of its marking level marked by the setting of the tens marking switch 140, the marking switch having been positioned in position 2, a circuit is established for relay 117 which may be traced from battery, off-normal terminals and wiper 141 of marking switch 140, winding of relay 117, wiper 121, terminal 170, wiper 119 to ground at the upper back contact of relay 118. Relay 117 now opens the circuit of the stepping magnet 114 of the group selector and closes the circuit of relay 118 extending from battery, through the upper winding of relay 118, the upper intermediate front contact of relay 133 to ground at the front contact of relay 117. Relay 118 then locks over its lower winding and inner lower front contact to off-normal ground on conductor 138 and switches marking ground at its upper contacts from conductor 119 of marking switch 140 to the wiper 143 of the units of marking switch 150. Until the marking switch 150 moves beyond its first terminal position relay 117 is held operated from ground over wiper 143, wiper 119, terminal 170, wiper 121, thence as traced through the winding of relay 117 to battery at wiper 141 so that if the units digit is one the group selector does not move further.

It has been assumed, however, that the units digit dialed was five and therefore when marking switch 150 moves beyond position 1, relay 117 releases and closes the circuit of magnet 114 of the group selector to advance it one step whereupon relay 117 again operates. In this manner the group selector follows the setting of the units marking switch step by step. When the units series of impulses ceases, relay 134 again deenergizes and establishes a circuit for relay 142 extending from battery, through the winding of relay 142, off-normal terminals and wiper 144 of

the units marking switch 150, lower front contact of relay 118, off-normal terminals and wiper 137 of tens marking switch 140, back contact of relay 134, inner upper front contact of relay 118 to ground at the front contact of relay 117. Relay 142 opens the locking circuit of relay 133 and during the releasing time of slow to release relay 133 a circuit is established for the test relay 146 extending from ground at the upper front contact of relay 142, the inner upper front contact of relay 133, upper winding of relay 146 to the test wiper 122, thence over the test terminal of the wanted line 160 to battery through the cut-off relay 148. If the line is idle, relays 148 and 146 operate and relay 146 locks over its lower winding and intermediate lower contact to off-normal ground on conductor 138. At its upper front contacts relay 146 switches through the talking connection from wipers 127 and 131 through condensers 149 and 151, back contacts of relay 123 and front contacts of relay 109 to wipers 128 and 129. At its inner lower front contact the test wiper 122 is connected to test wiper 125 so that the cut-off relays 103 and 148 of the calling and called lines are connected in parallel through the winding of relay 109 to ground at the front contact of relay 124.

Ringing current is now applied to the called line from the ringing current source 152 through the winding of ringing cut-off relay 145, the upper front contact of relay 136, the inner upper front contact of relay 146, wiper 131, thence over the called line 160 and through the sub-station bell returning over wiper 127, the upper front contact of relay 146, the inner upper front contact of relay 136 to ground at the lower front contact of relay 142. A ringing tone is transmitted to the calling line over the upper back contact of relay 133, condensers 153 and 151, thence as traced over the calling line. When the called subscriber answers, relay 145 energizes releasing relay 136 to disconnect the source of ringing current and ringing tone and to connect the windings of the back bridge relay 154 to the conductors of the called line. Relay 154 now operates in a circuit extending from battery, through its lower winding, upper back contact of relay 136, inner upper front contact of relay 146, wiper 131, thence over the called line, returning over wiper 127, the upper front contact of relay 146, to ground through the upper winding of relay 154.

A circuit is now effective for operating the calling line message register 155 which may be traced from ground, through the winding of message register magnet 155, wiper 156, lower front contact of relay 146 to battery through the inner lower back contact of relay 136. Upon the termination of the conversation, when the calling subscriber re-

stores his receiver, relay 126 releases followed by the release in turn of relays 124 and 109. When relay 109 releases it removes holding ground from conductor 138 thereby releasing all other operated relays of the link circuit and releasing the cut-off relays 103 and 148 of the calling and called lines. With relay 124 deenergized, a restoring circuit is established for marking switch 140 extending from battery, through the winding and interrupter contacts of magnet 132, off-normal terminals and wiper 157, to ground at the back contact of relay 124. When switch 140 reaches normal the winding of magnet 132 is disconnected from wiper 157 and ground from wiper 157 is extended over wiper 158 and the off-normal terminals of its bank through the interrupter contacts and magnet winding 139 of marking switch 150. Switch 150 is thereby restored to normal in which position the circuit of magnet 139 is opened. Group selector 110 returns to normal upon the seizure of the link circuit for the next call.

If the calling subscriber holds the line for thirty seconds after the called subscriber restores his receiver and releases back bridge relay 154, a circuit becomes established for the thermostatic relay 112 extending from battery, through the winding of relay 112, the lower front contact of relay 126, the upper back contact of relay 154, the inner upper back contact of relay 136 to ground at the lower front contact of relay 142 which is effective to connect battery over the upper contacts of jack 107, wiper 111, the back contact of line relay 102 to ground through the upper winding of fault relay 159. Relay 159 upon operating locks over its lower winding in a circuit extending over the calling line to ground at the upper contact of relay 159, and at its inner upper front contact connects a shunt over wiper 125 thereby causing relay 109 to deenergize and release the connection. The calling line cut-off relay 103 is also operated by relay 159, thereby preventing the line relay 102 from reoperating and an alarm circuit is closed over the lower contact of relay 159 to apprise the attendant that the calling subscriber has not restored his receiver as he should. As soon as the calling subscriber hangs up, relay 159 releases and restores the calling line to its normal condition.

In the foregoing description it was assumed that the wanted local line was reached over the wipers of the group selector 110. Had the called subscriber dialed 73125 for reaching a local line terminating in group selector 120 or 64125 for reaching a local line terminating in group selector 130, the connection would be established in the manner fully described in our copending application, Serial No. 234,215, filed concurrently herewith. Since the manner in which such

other local connections are established is not material to the present invention, no description thereof will be given herein.

Call through tandem office to distant office

5 In the foregoing description it has been assumed that the first three digits dialed by the calling subscriber indicated that a connection was desired with a local subscriber's line. If, however, these digits had for example been 742, indicative of a connection to be completed beyond the tandem office, then following the completion of dialing the third digit and the operation of relay 314, no immediate circuit would be completed for relay 332 as the translator bank terminal 352 upon which the wiper 344 is then resting is not cross-connected to cross-connection point 349. Consequently relay 215 is not at this time operated to cause the release of the trunk circuit and the remaining two digits of the line number dialed by the calling subscriber are received in the register translator circuit.

25 No record of the denomination of the fourth and fifth digits dialed is taken in the register circuit, but pairs of relays 327, 328 and 329, 331 are energized at the beginning and end of the tens and units digit series respectively under the control of relay 312. Thus, at the beginning of the fourth or tens digit a circuit is established from battery, through the winding of relay 327, back contact of relay 328, lower front contact of relay 314 to ground at the front contact of relay 312. Relay 327 thus operates locking through the winding of relay 328 and over its own contact to ground on conductor 353 but relay 328 being shunted does not operate. When relay 40 312 deenergizes, however, at the end of the tens digit series, relay 328 operates. At the beginning of the fifth or units digit series relay 312 again operates and establishes a circuit for relay 329 extending from battery through the winding of this relay, front contact of relay 328, thence as traced to ground at the front contact of relay 312. Relay 329 operates and locks in series with relay 331 over its own front contact to ground on conductor, but relay 331 being shunted at the front contact of relay 312 does not energize in this locking circuit. When, however, relay 312 deenergizes at the end of the units digit series relay 331 operates and establishes a circuit for relay 332 extending from battery through the winding of relay 332, the front contact of relay 331 to ground on conductor 353.

60 Metering control relays 213 and 214 are now connected over wipers 334 and 335 of the trunk finder 300 and front contacts of relay 332 to cross-connecting points 336 and 337 of cross-connecting rack 340. A further point 338 is connected by relay 332 to the winding of relay 339. It will be assumed

that for the particular setting of the translator switch in response to the digits 742 the translator bank terminal 352 is jumpered to the point 338 and that therefore following the operation of relay 332 a circuit is established for relay 339 extending through the winding of relay 339, over the inner lower front contact of relay 332, terminal 352, wiper 344, lower front contact of relay 333 which was operated with register 320 in position 4, the seventh terminal and wiper 342 of register 310, the lower front contact of relay 322 to ground on conductor 353. Relay 339 upon operating completes the circuits of both relays 213 and 214. Had the first three digits dialed been, for example, 732 or 642, then upon the operation of relay 332 the relay 339 would not be operated, but either relay 213 or relay 214 would be operated singly. Thus dependent upon the first digits dialed three metering conditions may be established by the operation of both or either of relays 213 and 214.

In addition to selectively operating the meter control relays 213 and 214, relay 332 connects direct ground over its upper contact, the inner upper front contact of relay 307, wiper 308 to battery through the winding of relay 211. Relay 211 upon operating establishes a locking circuit for itself and locking circuits for the operated meter control relays 213 and 214, and at its lower back contact opens the holding circuit of relay 307 which now releases in turn releasing all operated apparatus of Fig. 3. The impulses which were repeated by the relay 204 out over the trunk conductors 207 and 208 in the manner previously described have been instrumental in setting up a similar registration in the registering device of Fig. 7 and in setting up a connection at a distant office to the line of a desired subscriber. The registration set up in the registering device of Fig. 7 has no effect except to cause the dismissal of the tandem register sender as previously described since the first two digits registered have indicated that the connection is not to be terminated in the tandem office. When such subscriber answers the circuit extending over conductor 208 is momentarily opened thereby releasing relay 212. Relay 212 upon releasing now closes a circuit for relay 220 extending from battery, through the winding of relay 220, upper front contact of relay 211, upper back contact of relay 212 to ground on conductor 221. Relay 220 locks to conductor 221 and as soon as relay 212 again energizes, establishes a circuit for relay 209 extending over the upper front contact of relay 220, the front contact of relay 212 to ground on conductor 221. Relay 209 also locks to conductor 221 and establishes an obvious circuit for the time switch 222 which receives an impulse every two seconds from the master clock circuit.

A circuit is also established from battery, through the winding of metering switch magnet 223, wiper 224 and the normal terminal upon which it is resting, contact 225 of the time switch 222 to ground at the intermediate upper front contact of relay 209 for advancing the switch 200 one step off normal, from which position it rotates through a single cycle under the control of interrupter 226. As soon as the time switch 222 leaves normal it opens contact 225 so that when the metering switch 200 reaches normal its advance is arrested. With relays 213 and 214 both operated as previously described, when the wiper 227 of the metering switch 200 passes over the first, third and fifth terminals of its bank three metering impulses are transmitted over a circuit which extends from metering battery, through resistance 228, the upper front contact of relay 214, terminals and wiper 227 of switch 200, the lower back contact of relay 215, conductor 216, wiper 161, the lower front contact of relay 123, wiper 156 to ground through the message register magnet 155. These impulses are then followed by two further impulses transmitted from battery, through resistance 228, the lower front contact of relay 213, the seventh and ninth terminals and wiper 227 of switch 200, thence as traced through the winding of message register magnet 155.

After three minutes, time switch 222 again closes contact 225 and the metering switch 200 again completes a cycle transmitting five additional metering impulses. This sequence of operations continues if the connection is still held for conversation until nearly twelve minutes have elapsed. Ten seconds prior to the completion of the twelve minute period, the timing switch 222 closes contact 229 connecting a source of tone to the calling line as a warning that the twelve minute period is about to elapse. If the calling subscriber does not release the connection at the end of the twelve minute period, the timing switch 222 closes its contact 230 connecting a short-circuiting ground to the winding of relay 117 in the district link circuit over conductor 201, contact 230 to ground at the intermediate upper contact of relay 209. Relay 117 then releases in turn releasing relay 123 whereupon the calling line is disconnected from the windings of relay 204. Relay 204 then releases in turn releasing relays 205 and 206. Following the release of relay 206 the trunk circuit of Figs. 2, link circuit of Fig. 4, trunk circuit of Fig. 6 and all apparatus which has been taken into use thereby is released.

Relay 123 upon releasing now connects the calling line as previously described to the windings of relay 126 which thereupon energizes. If the calling subscriber does not now restore his receiver within thirty seconds, the thermostatic relay 112 operates over the lower front contact of relay 126, the normal ter-

minal and wiper 137 of marking switch 140, the back contact of relay 134, a back contact of relay 118 to off-normal ground on conductor 138. As previously described, relay 112 causes the operation of the calling line fault relay 159 which signals the attendant and causes the release of the district link circuit.

If the calling subscriber terminates the conversation prior to the completion of the twelve minute period, the restoration of his receiver releases relay 204 followed by the release of relays 205 and 206 and the restoration of the remaining equipment employed in the connection. If, however, the calling subscriber holds the connection after the called subscriber hangs up, for a period of thirty seconds, a circuit is established for the thermostatic relay 217 extending over the lower back contact of relay 212, which releases when the called subscriber hangs up, thence to ground at the lower front contact of relay 220. After the expiration of thirty seconds, relay 217 closes its lower contact thereby connecting direct ground to conductor 201 for shunting down relay 117. The forced release of the connection is then caused in the manner previously described. Similarly after the out pulsing loop over trunk conductors 207 and 208 is established by relay 204, if pulsing does not begin the circuit of relay 217 is established over the upper back contact of relay 211 and the inner upper front contact of relay 210 for a sufficient interval to cause relay 217 to start the forced release of the established connection.

In the preceding description it was assumed that both meter control relays 213 and 214 were operated and that thus for each unit period of conversation five metering impulses were transmitted by switch 200 for operating the calling line message register magnet. Had meter control relay 214 been operated alone it is obvious that but three metering impulses would have been transmitted and that similarly had relay 213 been operated alone but two metering impulses would have been transmitted.

Call initiated at tandem office for a local subscriber

When a call is initiated on a line local to the tandem office, assuming that such calling line is similar to the calling line 101 of Fig. 1 and appears in the bank of line finder 400 of Fig. 4, the line relay of such line closes the circuit of common start relay 403 and all line finders having access to that line are started. If it is assumed that the finder 400 is the finder which is to be used, its operating circuit is controlled in the manner previously described and when it seizes the calling line the link finder 500 is started to associate the register sender of Fig. 5 and the group selector 410 is operated to seize an outgoing

trunk in the manner previously described. When a trunk, for example, the trunk shown in Fig. 6, is seized an idle registering device such as that shown in Fig. 7 is associated therewith in the manner previously described. As soon as the apparatus associated with the distant end of trunk 607-608 is ready to receive impulses the calling subscriber receives a dial tone as previously described whereupon he commences to dial the digits of the wanted line number.

Since the calling subscriber wishes a connection with a subscriber's line which terminates in the tandem office, it will be assumed that he dials the number 63256 and that in response to the first two digits, registers 710 and 720 are positioned respectively in positions six and three and that following the setting of the register 720 the translator switch 730 is started to hunt for the group of terminals marked by the wiper 723 of the register 720. Since the register 723 is in engagement with its third terminal the translator under control of its wiper 725 will advance until the wiper 725 engages terminal 726 when the further movement of the translator will be arrested by the operation of relay 721. Following the termination of the second digit series relay 722 operates and locks to ground on conductor 753. These operations are all performed in the manner set forth in detail in connection with the description of Fig. 3.

With relay 722 operated and the translator wiper 745 in engagement with terminal 754, which terminal is commoned to the succeeding nine terminals of the same level corresponding to the tandem group of 1000 lines, a circuit is established for relay 732 extending from battery, through the winding of relay 732, cross-connection point 749; terminal 754, wiper 745, upper back contact of relay 733, wiper 742 of register 710 in position six, lower front contact of relay 722 to ground on conductor 753. Relay 732 upon operating establishes a circuit for relay 615 extending over wiper 747, the intermediate upper front contact of relay 732, back contact of relay 731 to ground on conductor 753. Relay 615 locks over its upper front contact to ground on conductor 621 and at its upper back contact removes busy potential from terminal 601 thereby releasing relays 425 and 428 in the tandem link circuit. With relay 425 released a circuit is established for relay 426 extending from battery, through the winding and lower normal contacts of relay 426, inner upper front contact of relay 429, back contact of relay 425 to ground at the inner upper front contact of relay 407. Relay 429 operates and locks over its inner lower front contact to ground on conductor 430 through the winding of relay 437. The energization of relay 615 also opens the circuit of relay 421 which upon releasing reconnects

the windings of relay 422 to the conductors of the calling line over front contacts of relay 407 and line finder wipers 418 and 419. Following the release of relay 421 ground for holding relay 414 operated is supplied from the front contact of relay 422.

The group selector 410 in addition to having access to outgoing trunk circuits also has access to groups of trunks terminating in third group finders. The terminals of the bank level to which wiper 427 has access, which correspond to third group finders, are commoned and connected to a contact on relay 438. Since relay 438 operated in a circuit extending through its winding, wiper 515, upper back contact of relay 514 to ground on conductor 553, upon the seizure of the link circuit by the link finder 500, these commoned terminals are connected over the inner upper front contact of relay 438, upper front contact of relay 426, through the lower winding of test relay 425 to ground at the inner upper front contact of relay 412. The group selector 410 is now started to hunt for an idle third group finder by a circuit extending from battery, through the winding and interrupter contacts of magnet 423, intermediate upper back contacts of relay 424, back contacts of relay 425 to ground at the front contact of relay 407. When an idle third group finder is found relay 425 operates in the circuit previously traced to the strapped terminals of group selector 410, thence over wiper 427, inner upper front contacts of relay 426, wiper 435 to battery potential on test terminal 439 of the trunk terminating in an idle third group finder. Relay 425 upon operating locks as before described over its upper winding in series with relay 428.

Relay 428 upon operating establishes a circuit for relay 424 extending from battery, through the winding of relay 424, lower front contact of relay 437, which operated in the locking circuit of relay 426, to ground at the front contact of relay 428. The tandem link circuit is now in condition to receive the last three digits of the wanted line number which have been assumed to be 256. In response to the dialing of the first of these digits relay 422 functions as a repeating relay and upon each deenergization repeats an impulse over a circuit which may be traced from ground at its back contact, upper front contact of relay 437, wiper 516, lower front contact of relay 507, winding of slow to release relay 517 to battery through the winding of pulsing relay 518. Relay 518 in turn repeats impulses over a circuit extending from its lower front contact, lower back contact of relay 514 to battery through the winding of stepping magnet 519 of the hundreds register 510. At the end of the first series of impulses relay 517 deenergizes and establishes a circuit for transfer relay 514 extending from battery, through the winding and inner lower normal contacts

of relay 514, off-normal terminals and wiper 521 of register 510 to ground at the back contact of relay 517. Relay 514 operates and locks to ground on conductor 553 and transfers the impulsing circuit from the winding of stepping magnet 519 to the winding of stepping magnet 522 of tens register 520 over the lower back contact of transfer relay 523. In response to the next digit series relay 518 now repeats impulses to the magnet 522 and at the end of this digit series relay 523 operates in a circuit extending from battery, through its winding and upper normal contacts, off-normal terminals and wiper 524 of register 520 to ground at the back contact of relay 517. Relay 523 then locks to ground on conductor 553 and transfers the pulsing circuit from magnet 522 to magnet 525 of the units register 530. In response to the last digit series relay 518 repeats impulses to the stepping magnet 525. The registers 510, 520 and 530 have now been set to register the digits 256.

As soon as the register 510 has registered the first of these digits a circuit is closed which may be traced from battery, over the upper front contact of relay 514, inner upper back contact of relay 526, inner upper back contact of relay 527, upper back contact of relay 528, intermediate lower front contact of relay 507, wiper 509, inner upper front contact of relay 424, lower back contact of relay 440, to wiper 434, thence to ground through a control relay in the third group finder, not shown. When the group finder is ready to receive impulses from the sender of Fig. 5, a circuit is established by the control relay of the group finder extending from battery thereat to the wiper 431, thence over the upper back contact of relay 440, the lower front contact of relay 434, wiper 531, inner lower front contact of relay 507, inner upper normal contacts of relay 528, lower normal contacts of relay 527 to ground through the winding of relay 532. Relay 532 thereupon operates and closes a circuit for relay 527 extending from battery, winding of relay 527, contact of relay 532 to ground over the normal terminal 533 and wiper 534 of impulse counting switch 540. Relay 527 thereupon locks over its lower front contact to ground over the segment 535 and wiper 536 of counting switch 540 and releases relay 532. At its inner front contacts relay 527 also extends the circuits previously traced from wipers 434 and 431 in a closed loop over wiper 542 of switch 540. At its upper front contact relay 527 also establishes an obvious operating circuit for stepping magnet 538 of switch 540 whereby the switch operates step-by-step interrupting the impulsing loop extending to the third group finder at the wiper 542 at each step.

When the wiper 534 reaches the terminal 539 marked by terminal 541 of register 510,

which it has been assumed has been positioned in position two, a circuit is established from ground, over wiper 534, terminal 539, wiper 541, upper back contact of relay 526 to battery through the winding of relay 537. Relay 537 operates closing a permanent loop of the out pulsing circuit in shunt of the wiper 542 thus stopping the transmission to the group finder of effective stepping impulses. Relay 537 also locks over its lower contact to ground over off-normal segment 535 and wiper 536. When the switch 540 advances beyond segment 543 the loop is closed over wiper 542 and segment 544. When wiper 536 advances beyond segment 535 the holding circuits of relays 527 and 537 are opened and these relays release, but switch 540 continues to advance into its normal position by means of a circuit closed over its off-normal switch contacts 545. When the wiper 534 passes over the terminal 546 an obvious circuit is closed for relay 526 which locks over its inner lower front contact to ground on conductor 553. The operation of the third group finder has thus selected a group of final selector switches and an idle one of such switches is selected in the well-known manner.

Upon the selection of the final selector a circuit is extended from battery at the upper contact of relay 514, over the inner upper front contact of relay 526, wiper 547 and the off-normal terminals of its bank if at this time the units digit has been registered, thence as traced to wiper 534 to ground in the final selector, not shown. When the final selector is ready to receive impulses of the tens digit it connects battery over the circuit established therefrom to the wiper 431, thence as traced to ground through the winding of relay 532. Relay 532 again operates in this circuit and in turn operates relay 527 to close the out pulsing loop over wiper 542 and starts the impulsing switch 540 in a second revolution. When wiper 534 leaves the terminal 533, relay 532 deenergizes, but relay 527 is held operated over wiper 536 and segment 535. As soon as wiper 534 reaches the terminal of the lower level of switch 540 upon which marking potential has been placed by wiper 548 of the tens register 520, which it was assumed has been set into position five, a circuit is effective from ground on wiper 534, over wiper 548, back contact of relay 549, the upper front contact of relay 526 to battery through relay 537. Relay 537 operates and performs the functions previously described. Switch 540 advances to its normal position and in passing terminal 550 establishes a circuit for relay 549 extending from ground, wiper 536, terminal 550, lower front contact of relay 526 to battery through the winding of relay 549. Relay 549 operates and locks over its upper contact to ground on conductor 553.

With switch 540 in its normal position relay 532 is again operated from the final selector and the counting switch then makes another revolution for transmitting impulses of the units series to the final selector. With relay 549 operated when the wiper 534 reaches a terminal marked by the wiper 551 of the units register 530 a circuit is established from ground on wiper 534, over wiper 551, the lower front contact of relay 549, the upper front contact of relay 526, for relay 537. In the manner previously described relay 537 stops the transmission of further impulses and when the wiper 536 reaches terminal 552 a circuit is established over the inner upper front contact of relay 549 to battery through the windings of relay 508. Relay 508 operates and locks over its windings and intermediate upper front contact, at its upper front contact short-circuits relay 513 and at its lower back contact opens the holding circuit of relay 505. Relay 505 in turn releases relays 512 and 507 and relay 507 in turn removes locking ground from conductor 553 for releasing all relays locked thereto. Upon the short-circuiting of relay 513 current flowing from ground on conductor 553, through the winding of relay 413 is increased to such an extent that relay 413 operates, locks and extends the talking conductors over its upper and inner lower contacts, over wipers 434 and 431, wipers of the third group finder and wipers of the final selector to the called line. Upon the response of the called subscriber, talking current is supplied to the called line through the winding of coil 432 and the winding of supervisory relay 433.

Relay 508 also establishes a restoring circuit for register 510 extending from battery, through the winding of magnet 519, wiper 554 and the off-normal terminals of its bank, the inner upper front contact of relay 508 in series over the interrupter contacts of magnets 519, 522 and 525 to ground at the contacts of jack 555. When the register 510 reaches normal the restoring circuit is extended from wiper 554 and its normal terminal to wiper 556 and off-normal terminals of register 520 to battery through the winding of magnet 522. When register 520 reaches normal this circuit is further extended over wiper 556 and its normal terminal, wiper 557 to the winding of magnet 525. As soon as the register 530 reaches normal this circuit is further extended over wiper 557 and its normal terminal to the inner lower front contact of relay 508 thereby shunting relay 508 and causing its release. All operated apparatus of the sender of Fig. 5 has now been restored to normal.

Should the sender fail to complete its functions within a predetermined period after the completion of the transmission of the hundreds impulses, i. e., after relay 526 operates and establishes the circuit of thermostatic re-

lay 508, relay 509 closes its upper contact operating relay 528 which locks to ground on conductor 553, shunts one winding of relay 513 from the circuit of relay 413 to permit the operation of the latter relay and connects the tone coil 561 to the calling line over its upper front contacts and the front contacts of relay 413. Relay 509 also opens the circuit of relay 505 thereby releasing the sender. The subscriber receiving the tone is apprised of the fact that the connection cannot be established and proceeds to release the connection.

On a call within the tandem office repeated metering on a single tariff is provided, but a variable tariff may be provided, if desired. The destination of the call is indicated by the hundreds digit registered by register 510, and if the call is such as requires repeated metering, ground is connected over wiper 558 cross-connection point 559, which will be assumed to be jumpered to the second position terminal of the bank with which wiper 558 is associated, thence over wiper 560 to battery through relay 441. Relay 441 thus operates and locks to ground on conductor 430 before the sender is released as above described.

When the called subscriber answers and relay 433 operates a circuit is established from ground on conductor 430, front contact of relay 433 to battery through the winding of relay 440. Relay 440 operates and locks to ground on conductor 430 and at its inner upper front contact connects the clock circuit to the timing switch magnet 442. This timing switch is similar to the timing switch shown more in detail in Fig. 2. As soon as the timing switch 442 closes contact 443 with relay 441 operated a circuit is closed for the magnet 444 of the meter impulsing switch 420 extending from ground over contact 443, normal terminal, wiper 445 and magnet 444 of the impulsing switch, inner upper front contact of relay 441 to battery at the lower front contact of relay 440. As soon as the switch 420 leaves normal, ground is supplied for advancing it through a complete revolution to normal from interrupter 446 in which position it is arrested until the timing switch again closes contact 443 after an interval of three minutes. As the wiper 447 passes over the first and third terminals of its bank a circuit is established from battery, over wiper 447, upper alternate contacts of relay 441, wiper 448 of the line finder 400, thence to ground through the calling line message register, magnet, thus operating the message register twice. As the timing switch 442 continues to advance the switch 420 will rotate through a cycle for each three-minute period of conversation. Just prior to the expiration of twelve minutes the calling subscriber will receive a warning tone and if he does not disconnect immediately a peremptory disconnection will take effect at the end of the twelve-minute period in the manner previ-

ously described in connection with Fig. 2. When the calling subscriber restores his receiver relay 422 releases in turn releasing relay 414 whereupon the remaining relays of the tandem link circuit release.

If repeated metering is not required the jumper to the cross-connection point 559 in the sender is omitted and relay 441 is therefore not operated. When therefore relay 440 operates following the response of the called subscriber, metering current is applied but once from battery, over the lower front contact of relay 440, the upper back contact of relay 441, wiper 448 and thence to the message register of the calling line. In this case the circuit of impulsing switch 420 is not effective since it is open at the upper front contact of relay 441.

What is claimed is:

1. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, zone relays and a message register impulsing switch associated with said trunk circuit, means for selectively operating said relays in accordance with the destination of a call, and means controlled by said impulsing switch for variably operating the message register under the control of said relays.

2. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, zone relays, a message register impulsing switch and a timing switch associated with said trunk circuit, means for selectively operating said relays in accordance with the destination of a call, and means controlled by said timing switch to repeatedly operate said impulsing switch to variably and periodically operate said message register under the control of said relays.

3. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, means associable with said selected trunk circuit for registering certain digits of wanted line numbers, zone relays and a message register impulsing switch in said trunk circuit, means controlled by said registering means for selectively operating said relays in accordance with the destination of a call, and means controlled by said

impulsing switch for variably operating the message register under the control of said relays.

4. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, means associable with said selected trunk circuit for registering certain digits of wanted line numbers, zone relays and a message register impulsing switch in said trunk circuit, means controlled by said registering means for selectively operating said relays in accordance with the destination of a call, and means controlled by said impulsing switch for variably and periodically operating the message register under the control of said relays.

5. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, means associable with said selected trunk circuit for registering certain digits of wanted line numbers, zone relays, a message register impulsing switch and a timing switch in said trunk circuit, means controlled by said registering means for selectively operating said relays in accordance with the destination of a call, and means controlled by said timing switch to repeatedly operate said impulsing switch to variably and periodically operate said message register under the control of said relays.

6. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, means associable with said selected trunk circuit for registering certain digits of wanted line numbers, zone relays, a message register impulsing switch and a timing switch in said trunk circuit, means controlled by said registering means for selectively operating said relays in accordance with the destination of a call, means controlled by said timing switch to repeatedly operate said impulsing switch to variably and periodically operate said message register under the control of said relays, and means controlled by said timing switch after a predetermined interval to signal the calling subscriber.

7. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing

trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, means associable with said selected trunk circuit for registering certain digits of wanted line numbers, zone relays, a message register impulsing switch and a timing switch in said trunk circuit, means controlled by said registering means for selectively operating said relays in accordance with the destination of a call, means controlled by said timing switch to repeatedly operate said impulsing switch to variably and periodically operate said message register under the control of said relays, means controlled by said timing switch after a predetermined interval to signal the calling subscriber to release the connection and means operable after a further predetermined interval to peremptorily release the connection if the calling subscriber does not release in response to said signal.

8. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, a plurality of registering devices common to said trunk circuits, means operative upon seizure of a trunk circuit for associating an idle registering device with said trunk circuit, means for causing the registration in said device of certain digits of wanted line numbers, zone relays and a message register impulsing switch in said trunk circuit, means controlled by said registering device for selectively operating said relays in accordance with the destination of a call, and means controlled by said impulsing switch for variably operating the message register under the control of said relays.

9. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits accessible to said switch, a calling line having a message register, means for associating said line with said link circuit, means for operating said switch to select an idle trunk circuit, a plurality of registering devices common to said trunk circuits, means operative upon the seizure of a trunk circuit for associating an idle registering device with said trunk circuit, means for causing the registration in said device of certain digits of wanted line numbers, zone relays and a message register impulsing switch in said trunk circuit, means controlled by said registering device for selectively operating said relays in accordance with the destination of a call, means controlled by said relays for releasing said registering device, and means controlled by said impulsing switch for variably oper-

ating the message register under the control of said relays.

10. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits and local subscribers' lines accessible to said switch, a calling line having a message register, means for associating said calling line with said link circuit, means for operating said switch to select an idle trunk circuit, zone relays and a message register impulsing switch associated with said trunk circuit, means for selectively operating said relays in accordance with the destination of a call, means controlled by said impulsing switch for variably operating the message register only if said relays designate outgoing calls, and means controlled by said relays for releasing said trunk circuit if the call designated is to be terminated on one of said local lines.

11. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits and local subscribers' lines accessible to said switch, a calling line having a message register, means for associating said calling line with said link circuit, means for operating said switch to select an idle trunk circuit, zone relays and a message register impulsing switch associated with said trunk circuit, means for selectively operating said relays in accordance with the destination of a call, means controlled by said impulsing switch for variably operating the message register only if said relays designate outgoing calls, means controlled by said relays for releasing said trunk circuit if the call designated is to be terminated on one of said local lines, means for further operating said selector switch to extend a connection to a local subscriber's line, and means in said link circuit operative upon the response of the called local subscriber for operating the calling line message register.

12. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits and local subscribers' lines accessible to said switch, a calling line having a message register, means for associating said calling line with said link circuit, means for operating said switch to select an idle trunk circuit, a plurality of registering devices common to said trunk circuits, means operative upon the seizure of a trunk circuit for associating an idle registering device with said trunk circuit, means for causing the registration in said device of certain digits of wanted line numbers, zone relays and a message register impulsing switch in said trunk circuit, means controlled by said registering device for selectively operating said relays in accordance with the destination of a call, means controlled by said impulsing switch

for variably operating the message register only if said relays designate outgoing calls, means controlled by said relays for releasing said trunk circuit if the call designated is to be terminated on one of said local lines, means for further operating said selector switch to extend a connection to a local subscriber's line, and means in said link circuit operative upon the response of the called local subscriber for operating the calling line message register.

13. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits and local trunk circuits accessible to said switch, said local trunk circuits having access to local subscribers' lines, a calling line having a message register, means for associating said calling line with said link circuit, means for operating said switch to select an idle trunk circuit, zone relays and a message register impulsing switch associated with said trunk circuit, means for selectively operating said relays in accordance with the destination of a call, means controlled by said impulsing switch for variably operating the message register only if said relays designate outgoing calls, means controlled by said relays for releasing said outgoing trunk circuit if the call designated is to be terminated on one of said local lines, means for further operating said selector switch to extend a connection toward a local line, and means in said link circuit operative upon the response of the called local subscriber for periodically operating the calling line message register.

14. A telephone exchange system comprising a link circuit terminating at one end in a selector switch, a group of outgoing trunk circuits and local trunk circuits accessible to said switch, said local trunk circuits having access to local subscribers' lines, a calling line having a message register, means for associating said calling line with said link circuit, means for operating said switch to select an idle trunk circuit, zone relays and a message register impulsing switch associated with said trunk circuit, means for selectively operating said relays in accordance with the destination of a call, means controlled by said impulsing switch for variably operating the message register only if said relays designate outgoing calls, means controlled by said relays for releasing said outgoing trunk circuit if the call designated is to be terminated on one of said local lines, means for further operating said selector switch to extend a connection toward a local line, a timing switch in said link circuit, and means in said link circuit operative upon the response of the called local subscriber for periodically operating the calling line message register under the control of said timing switch.

15. A telephone exchange system comprising a link circuit terminating at one end in

a selector switch, a group of outgoing trunk circuits and local trunk circuits accessible to said switch, said local trunk circuits having access to local subscribers' lines, a calling line having a message register, means for associating said calling line with said link circuit, means for operating said switch to select an idle trunk circuit, zone relays and a message register impulsing switch associated with said trunk circuit, means for selectively operating said relays in accordance with the destination of a call, means controlled by said impulsing switch for variably operating the message register only if said relays designate outgoing calls, means controlled by said relays for releasing said outgoing trunk circuit if the call designated is to be terminated on one of said local lines, means for further operating said selector switch to extend a connection toward a local line, a timing switch in said link circuit, means in said link circuit operative upon the response of the called local subscriber for periodically operating the calling line message register under the control of said timing switch, means controlled by said timing switch after a predetermined interval for signaling said calling subscriber to release the connection, and means operable a predetermined interval thereafter to peremptorily release the connection if the calling subscriber does not release in response to said signal.

16. In a telephone exchange system, a plurality of offices, subscribers' lines terminating in each of said offices, each of said lines having a message register, switching apparatus operative in response to the initiation of a call on a line of any office to extend a connection in tandem through succeeding offices, a digit registering device in each of said offices, means in each office responsive to the control of a calling subscriber therein for simultaneously causing the registration of digits of called line numbers upon the registers of a registering device of each of said succeeding offices, means in each of said offices controlled by the registering device of that office for controlling the operation of a calling subscriber's message register in accordance with the zone of the exchange area in which a call is to be terminated, and means for rendering effective only the message register operating means of the office in which the call is initiated.

17. In a telephone exchange system, a plurality of offices arranged in tandem, subscribers' lines terminating in each of said offices, each of said lines having a message register, trunk circuits connecting each of said offices to the next succeeding office, switching apparatus operative in response to the initiation of a call on a line of any office to extend a connection in tandem over said trunk circuits through succeeding offices, digit registering

devices in each of said offices, means responsive to the seizure of a trunk circuit outgoing from each office to associate an idle registering device of that office with the trunk circuit outgoing from that office, means in each office responsive to the control of a calling subscriber for simultaneously causing the registration of digits of called line numbers upon the registers of the registering device of each of said succeeding offices, means controlled by the registering device of each office for controlling the operation of a calling subscriber's message register in accordance with the zone of the exchange area in which a call is to be terminated, and means for rendering effective only the message register operating means of the office in which the call is initiated.

18. In a telephone exchange system, a plurality of offices arranged in tandem, subscribers' lines terminating in each of said offices, each of said lines having a message register, trunk circuits connecting each of said offices to the next succeeding office, switching apparatus operative in response to the initiation of a call on a line of any office to extend a connection in tandem over said trunk circuits through succeeding offices, digit registering devices in each of said offices, means responsive to the seizure of a trunk circuit outgoing from each office to associate an idle registering device of that office with such trunk circuit, means in each office responsive to the control of a calling subscriber for simultaneously causing the registration of digits of called line numbers upon the registers of the registering device of each of said succeeding offices, zone relays in each of said trunk circuits under the control of the associated registering device for variably controlling the operation of a calling line message register in accordance with the zone of the exchange area in which a call is to be terminated, and means for rendering effective only the zone relays of that office in which the call is initiated.

In witness whereof, we hereunto subscribe our names this 19th day of February, 1930.

WILLIAM HATTON.

CHARLES DE VRIENDT.

ERNEST JEAN ROUSSEAU.