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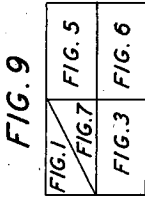
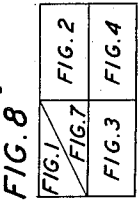
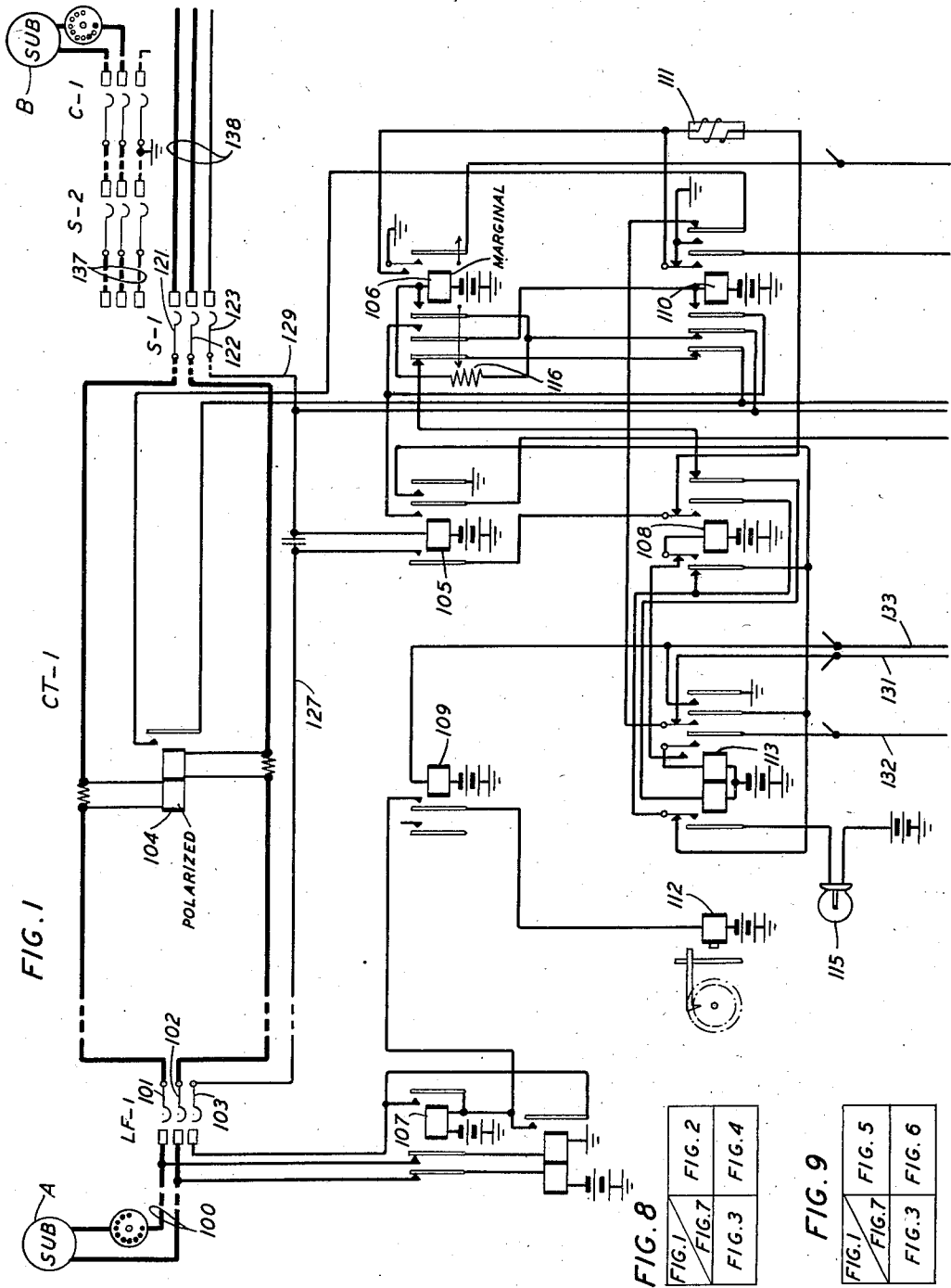
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2,042,561

TELEPHONE SYSTEM

Filed Oct. 11, 1934

7 Sheets-Sheet 1



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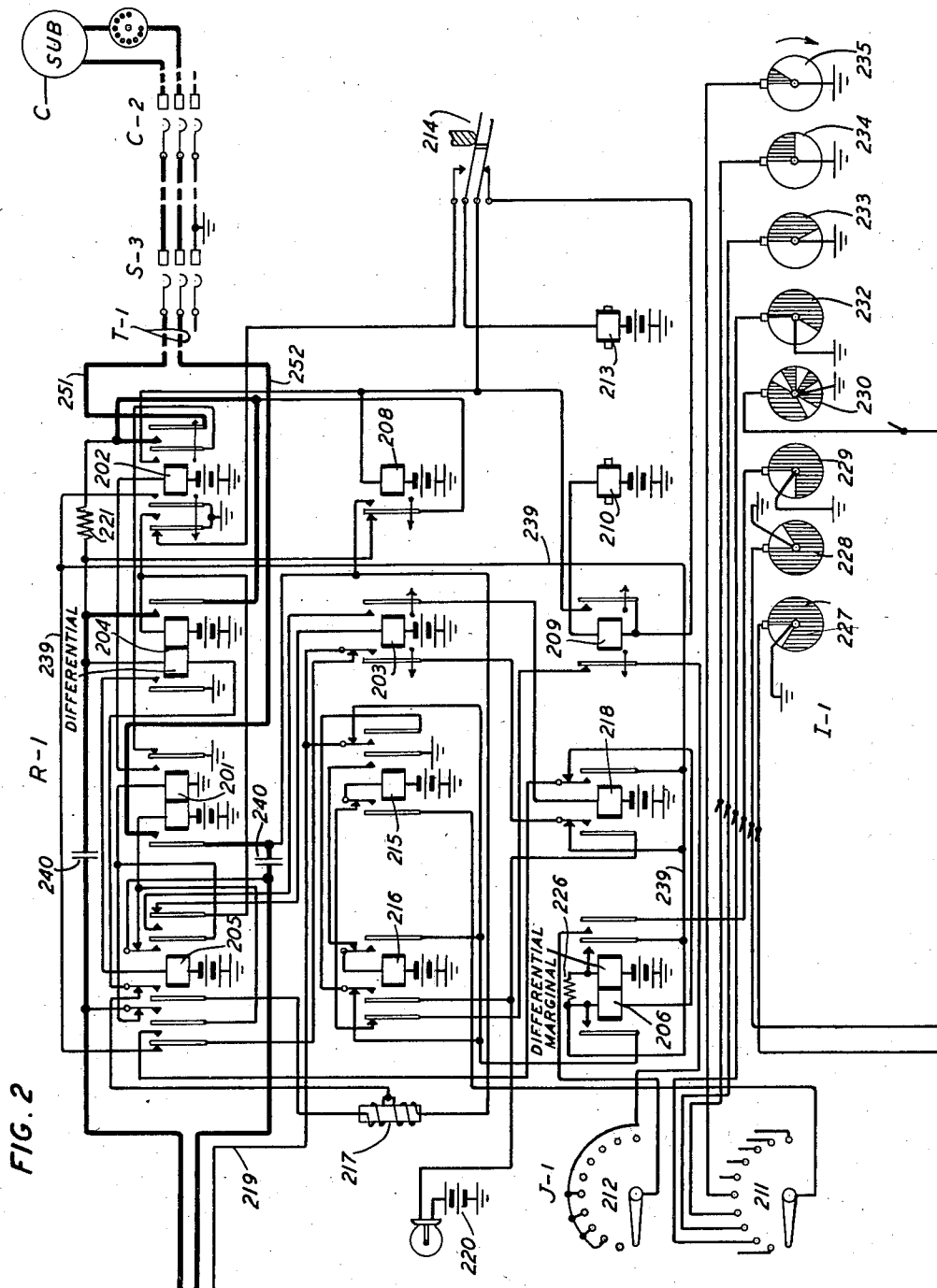
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7 Sheets-Sheet 2



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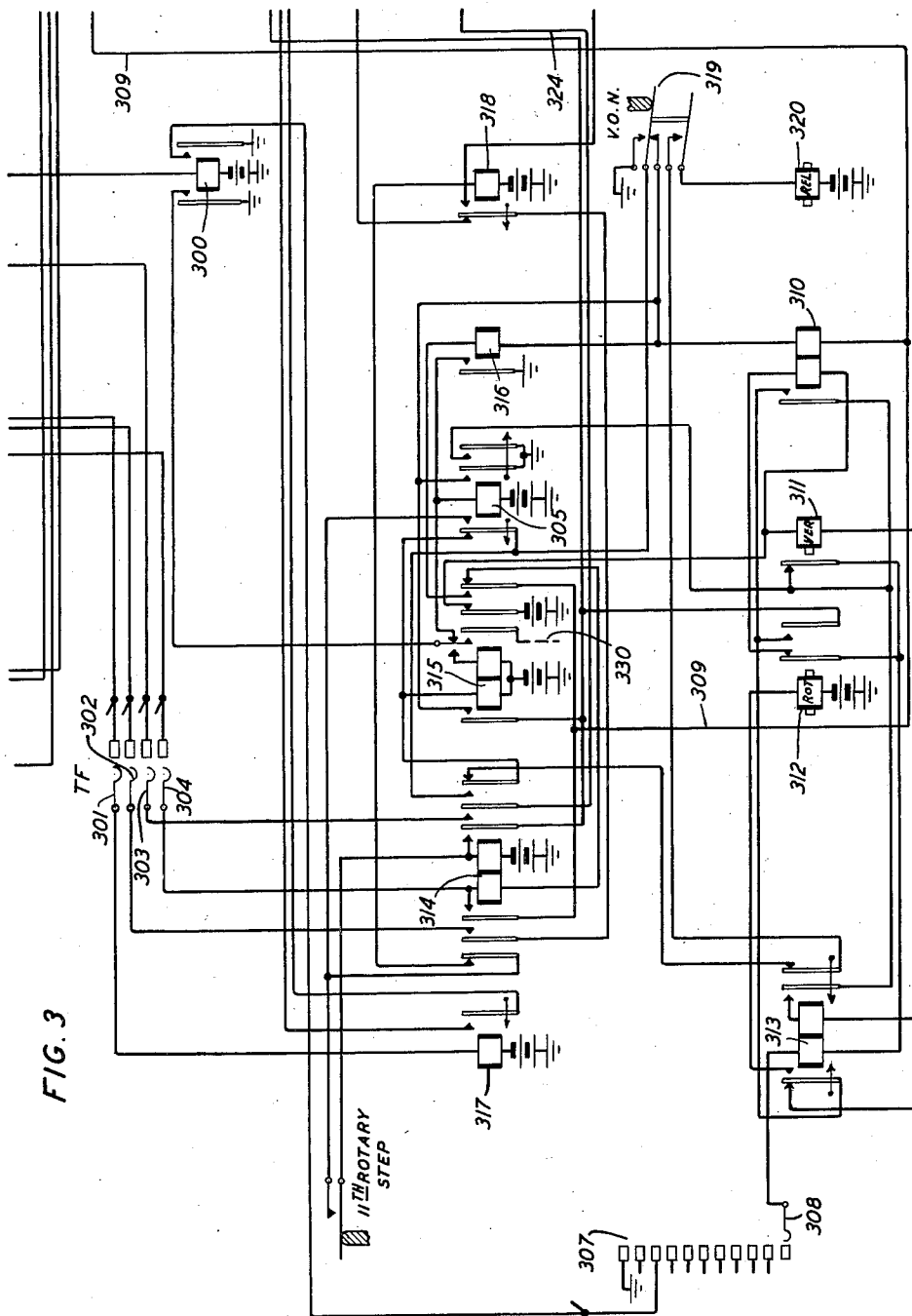
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7 Sheets-Sheet 3



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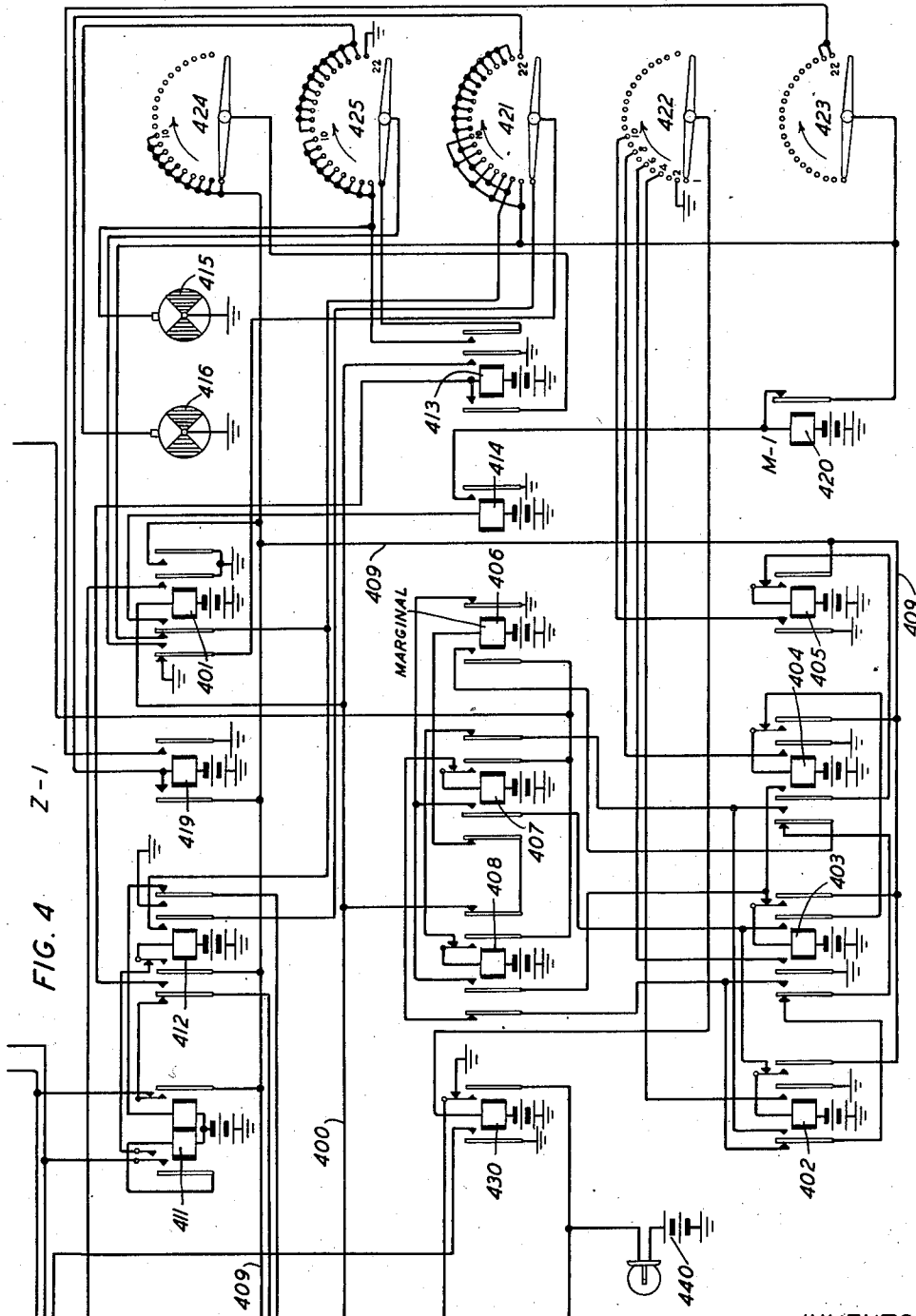
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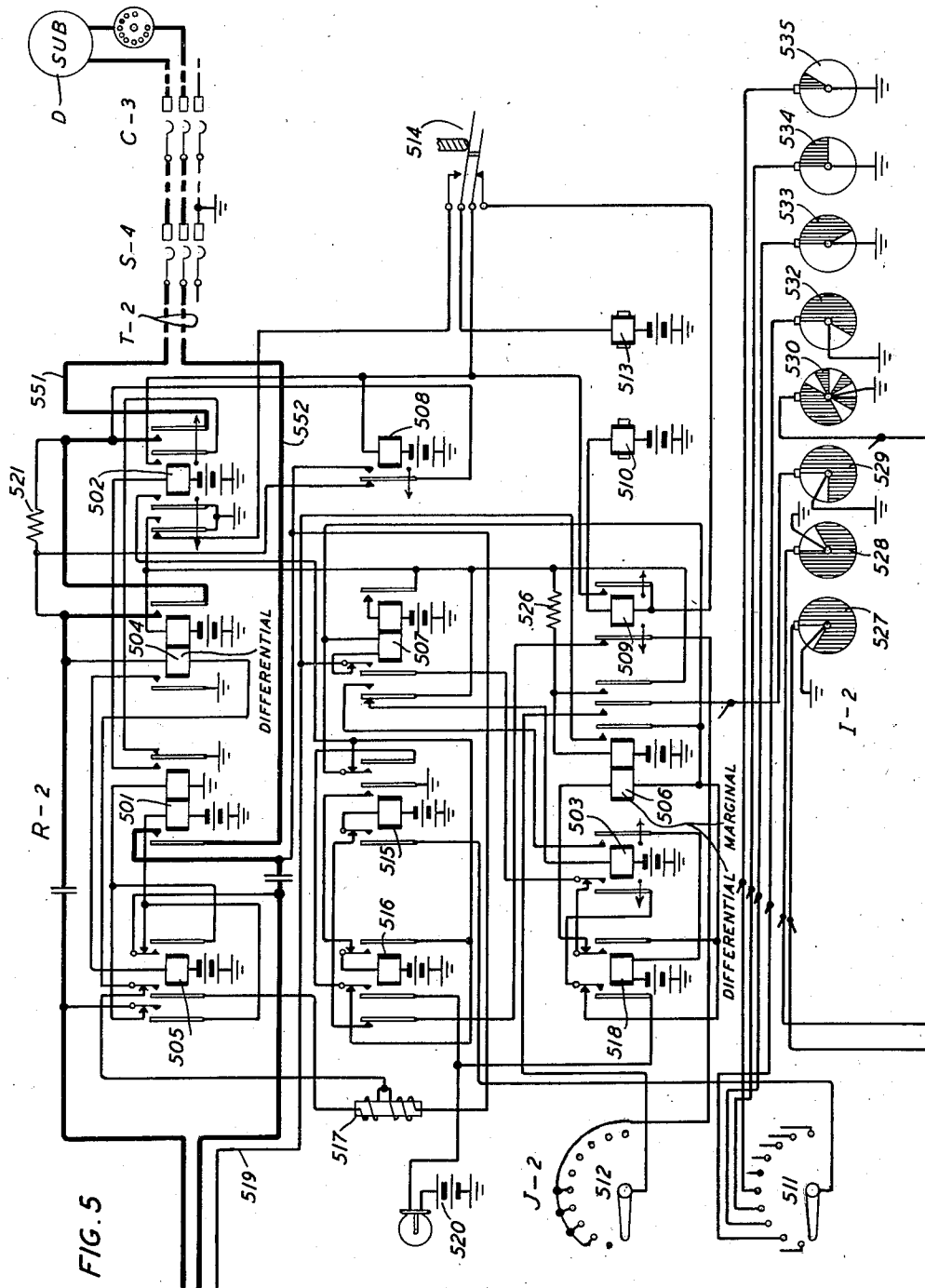
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7 Sheets-Sheet 5



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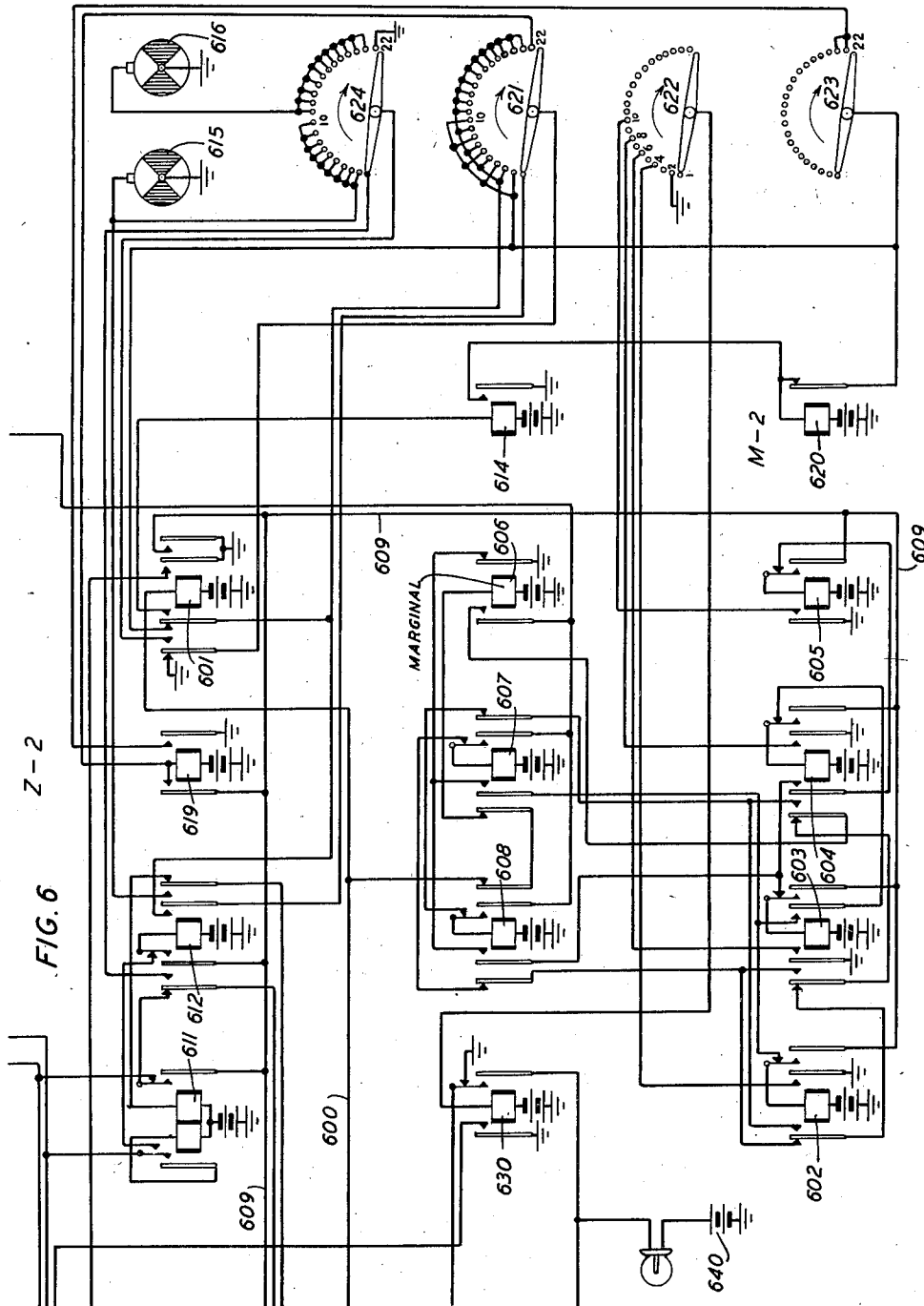
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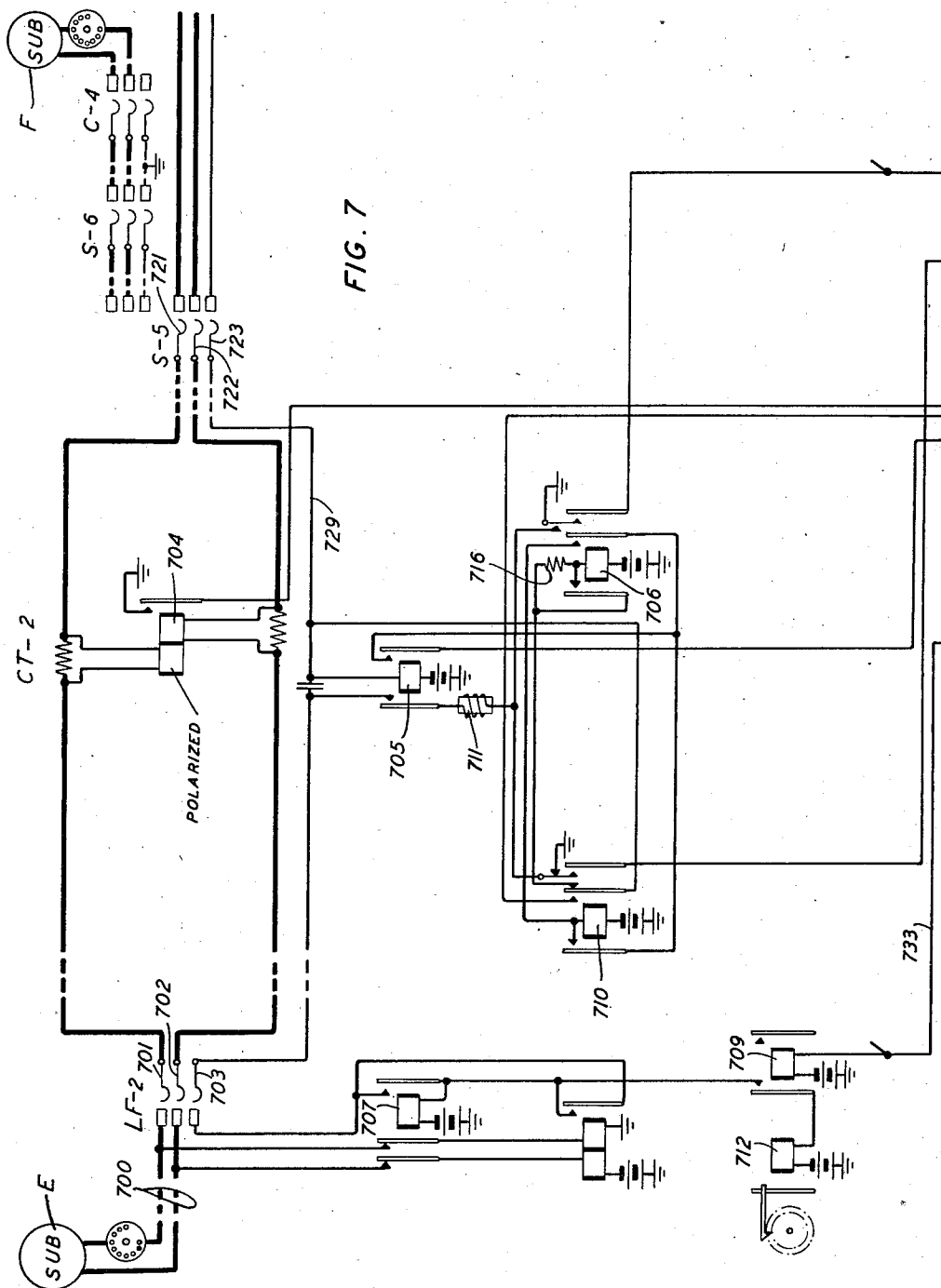
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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

2,042,561

TELEPHONE SYSTEM

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Application October 11, 1934, Serial No. 747,831

17 Claims. (Cl. 179-7.1)

This invention relates to telephone systems and particularly to measured service telephone systems.

The object of the invention is to provide a reliable and economical arrangement for registering variable charges for telephone service.

In multi-office automatic telephone systems which provide measured service, the charge for a call may vary in accordance with the location of the called line with respect to the calling line and in accordance with the duration of the call. It is usual in such systems to provide meter operating means in a trunk included in the talking connection between a calling line and the first impulse responsive selector switch employed in establishing connection with a called line. Means for indicating the zone or location of the called line is commonly located in the outgoing trunk repeaters, and timing mechanism for measuring off the periods of time, for each of which a charge is registered, is commonly located either in the outgoing repeater or in the charging trunk.

According to this invention, zone metering and timing equipment is provided in an automatic telephone system for operative association with any one of a plurality of charging trunks.

According to this invention, switching means are provided for associating an idle zone metering and timing unit with a charging trunk leading to a first selector switch on calls involving an outgoing repeater, zone indicating signals being thereupon transmitted from the outgoing trunk repeater for recording in the zone metering and timing unit. A feature of the invention is a trunk finder switch for connecting an associated time and zone metering equipment to the charging trunk leading to a first selector, such a connection being established in response to a signal from the outgoing trunk repeater circuit through which the call is being completed. A further feature is the provision of means, in such a time and zone metering equipment, operative in response to its connection with a charging trunk for transmitting a signal to the outgoing trunk repeater through which the call is being completed to initiate the transmission of zone indicating signals from the outgoing trunk, these signals being registered in the time and zone metering apparatus.

Another feature of the invention is a message rate charging trunk arranged to operate a calling subscriber's meter once on local calls and arranged to initiate, in response to a signal received from the outgoing repeater through which an interoffice call is being completed, the connection

of an idle time and zone metering equipment for use in charging for the call.

A telephone system in which the invention is embodied is shown in the drawings which form a part of this specification. The use of the invention is, however, not limited to the particular system shown and other applications of the invention will readily occur to one skilled in the art.

Referring now to the drawings:

Fig. 1 shows a calling subscriber's station A, a line finder LF-1, a charging trunk CT-1 permanently connecting the finder LF-1 to a first selector S-1, an intermediate selector S-2, a connector C-1, and a called subscriber's station B; the trunk CT-1 is for use with message-rate subscriber's lines;

Fig. 2 shows a repeater R-1 associated with an interoffice trunk T-1, an incoming selector S-3 to which the distant end of trunk T-1 is connected, a connector C-2, and a called subscriber's station C;

Fig. 3 shows a trunk finder TF, the terminals in its bank being connected to charging trunks such as and including the trunk CT-1 of Fig. 1;

Fig. 4 shows a zone metering and timing apparatus Z-1 which is individual to and permanently associated with the trunk finder TF and which is arranged for use in a system including repeaters such as R-1 shown in Fig. 2;

Fig. 5 shows a repeater R-2 associated with an interoffice trunk T-2, an incoming selector S-4 to which the distant end of trunk T-2 is connected, a connector C-3 and a called subscriber's station D;

Fig. 6 shows a zone metering and timing apparatus Z-2 for use in a system including the repeater R-2 shown in Fig. 5;

Fig. 7 shows a calling subscriber's station E, a line finder LF-2, a charging trunk CT-2 permanently connecting the finder LF-2 to a first selector S-5, an intermediate selector S-6, a connector C-4 and a called subscriber's station F; for flat-rate subscribers' lines, the charging trunk arrangement shown in Fig. 7 is used in place of that shown in Fig. 1;

Figs. 8 and 9 show how Figs. 1 to 7, inclusive, should be placed to form operative arrangements.

The line finder, selector, connector and trunk finder switches shown in the drawing are all of the well-known two-motion Strowger type and each of these switches is represented in the drawing by a set of brushes and one or two sets of terminals. The trunk finder TF is shown complete but the broken lines leading to the brushes of the other switches represent apparatus and

connections which have been omitted. For a complete description of the line finders LF—1 and LF—2 reference may be had to my Patent No. 1,799,654, granted April 7, 1931. For a complete description of the operation of the selector and connector switches reference may be had to pages 53 to 67, inclusive, of the second edition of "Automatic Telephony" By Smith and Campbell, published in 1921.

The charging trunk CT—1 (Fig. 1) is arranged for use with message-rate subscribers' lines and comprises the usual polarized supervisory relay 104 operable by a reversal of current in response to the removal of the receiver at the called subscriber's station to initiate metering, a relay 106 responsive to the connection of booster-battery potential to the sleeve conductor 129 on inter-zone calls to start an idle trunk finder such as TF through which the trunk CT—1 is extended to an idle zone metering control unit Z—1 (or Z—2). The trunk CT—1 also includes a relay 113, the operation of which connects booster-battery potential to the sleeve conductor 127 to operate the calling subscriber's meter.

The charging trunk CT—2 (Fig. 7) is arranged for use with flat-rate subscribers' lines and comprises the usual polarized supervisory relay 704, a relay 706 responsive to the connection of booster-battery potential to sleeve conductor 729 on inter-zone calls to start an idle trunk finder TF by which the trunk CT—2 is extended to an idle zone metering control unit Z—1 (or Z—2).

The repeaters R—1 and R—2 and the zone metering control units shown in the drawings are adapted for use in systems having five charging zones but may be modified for use with systems having any number of zones.

The repeater R—1 comprises a line relay 201, a register switch J—1, means responsive to the answer of the called subscriber for transmitting a signal to the charging trunk to initiate the association of a zone metering control unit with the charging trunk, and interrupter controlled means for transmitting zone indicating signals over the sleeve conductor, through the charging trunk CT—1 (or CT—2), to the zone metering control unit to which the charging trunk is connected. The line relay 201 responds to the dial impulses created by the operation of the calling subscriber's dial and is effective to repeat these impulses over the trunk T—1 to control the selective operation of the succeeding switches employed in completing the desired connection. Relay 201 also repeats the impulses created by the dialing of the first digit to advance register switch J—1 to a corresponding position, which position is indicative of the zone within which the called line is located. The register J—1 may be modified so as to selectively respond to more than one digit in case the registering of one digit is insufficient to determine the zone within which the line of a called subscriber is located.

The repeater R—2 is similar to the repeater R—1 except that it is arranged to immediately transmit upon seizure, a signal to the charging trunk CT—1 (or CT—2) to indicate that the call is an interoffice call without waiting for the called subscriber to answer.

The zone metering and timing unit Z—1 is arranged for use with repeater R—1 and comprises zone register relays 402, 403, 404 and 405 which are effective upon operative connection of the unit with a charging trunk to register the zone within which the called line is located as indicated by the signals received over the sleeve conductor

of the charging trunk from the repeater. Upon removal of the receiver at the called station, as indicated by the operation of the polarized supervisory relay of the charging trunk, the control unit is effective to initiate the advance of the timing switch M—1 to cause the operation of the calling subscriber's meter once, twice, three times, four times or five times, the number of meter operations being controlled by the zone register relays. The timing switch M—1, comprising stepping magnet 420 and terminal banks 421, 422, 423, 424 and 425, is also effective to measure off five-minute periods of time during the maintenance of a talking connection between the calling and called stations.

The zone metering and timing control apparatus Z—2, which is arranged for use with repeater R—2, is similar to the control unit Z—1 except that advance of timing switch M—2 awaits the operation of the zone register relays 602, 603, 604 and 605.

As shown, the zone metering and timing control units Z—1 and Z—2 are arranged so that the charge for each overtime period is the same as for the initial period and so that the length of an overtime period is the same as the initial period. These control units may, however, be readily modified so that the overtime charge may vary both in the number of meter operations and in its duration from the initial charge. A table showing six of the many possible charging plans which may be used in systems having five zones is found in my Patent No. 1,859,941, granted May 24, 1932.

The interrupter I—1 in Fig. 2 and interrupter I—2 in Fig. 5 are similar, the reference characters being the same for corresponding elements except for the hundreds digit. All of the drums of each interrupter may be mounted on a common driving shaft. In any event, all of these drums have a three-second cycle of rotation. Referring to interrupter I—1, drums 227, 228, 229, 232, 233, 234 and 235 connect their brushes to ground once per cycle. The closure through drums 227, 229, 232, 233, 234 and 235 begins simultaneously. The closure through drum 227 endures for .5 second, the closure through drum 229 endures for .75 second, the closure through drum 232 endures for 1.25 seconds, the closure through drum 233 endures for 1.75 seconds, the closure through drum 234 endures for 2.25 seconds, and the closure through drum 235 endures for 2.75 seconds. The closure through drum 228 begins two seconds after the closure through drum 227 terminates and endures for .5 second. The brush of drum 230 is connected to ground four times per cycle, each closure enduring for .25 second; the first closure occurs .25 second after the closure through drum 229 terminates and .25 second elapses between the end of each of the first, second and third closures and the beginning of the second, third and fourth closures, respectively. The interrupters I—1 and I—2 are common to a plurality of charging trunks, a plurality of repeaters and a plurality of zone metering control units.

The operation of the system comprising Figs. 1, 2, 3 and 4 will be described, it being assumed that a call is originated at the message-rate subscriber's station A. The line 100 is thereupon extended through the brushes of a line finder LF—1, through the associated charging trunk CT—1 to the line relay (not shown) of the associated first selector S—1 in well-known manner. Upon connection of a holding ground po-

tential from selector S—2 to sleeve conductor 129, relay 105 is operated thereby connecting the sleeve conductor 127 of trunk CT—1, through its left front contact, the back contact of the right continuity spring of relay 108, and through impedance 111, to ground at the inner right back contact of relay 110. This connection to ground serves to hold the cut-off relay 107 operated and to prevent the return of the line finder LF—1 to normal. Relay 106 is marginal and does not operate when ground potential is connected to conductor 129. In response to the impulses created by the dialing of the first digit of the number of the subscriber's station with which connection is desired, the selector S—1 operates to select a set of terminals in the corresponding level of its bank, which set of terminals connect to an idle trunk 137 leading to a second selector S—2 in the same office or connect to a trunk 138 leading to a repeater R—1 and thence over an inter-office trunk T—1 to an incoming selector S—3 in another office.

If the called station is in the same office as the calling station, the impulses created by the dialing of the succeeding digits of the called subscriber's number control the selective operation of a second selector S—2, the selective operation of intermediate selectors, if any, and the selective operation of a connector C—1 to establish connection with the line leading to the called station B. The called station is signaled in the usual manner and when the call is answered the usual reversal of current in the talking conductors of trunk CT—1, and line 100 cause the operation of the polarized supervisory relay 104. The operation of relay 104 connects the left winding of relay 113, through the outer right back contact of relay 108, back contact of relay 106, outer left back contact of relay 110, front contact of relay 104, outer right back contact of relay 119, back contact of the right continuity spring of relay 113 over conductor 131 to the brush of drum 227 of interrupter I—1. As soon after relay 104 operates as the brush of interrupter drum 227 is connected to ground, relay 113 operates and closes a locking circuit through the front contact of its right continuity spring to ground at the outer right front contact of relay 105. Relay 113 also connects its right winding in parallel with the winding of relay 108 over conductor 132 to the brush of interrupter drum 228 and closes a circuit for operating relay 109. When the brush of interrupter 228 is next connected to ground, approximately but not less than two seconds after relay 113 operates, relay 108 is operated and the right winding of relay 113 is energized to hold relay 113 operated. Relay 108 locks through the front contact of its continuity spring to ground at the outer right front contact of relay 105 and opens the circuit through the left winding of relay 113. With relays 113, 109 and 108 all operated, a circuit for operating the calling subscriber's meter 112 is traced from the negative pole of battery through the winding of meter 112, a front contact of register control relay 109, front contact of cut-off relay 107, sleeve terminal and brush 103 of line-finder LF—1, conductor 127, left front contact of relay 105, front contact of the right continuity spring of relay 108, front contact of the left continuity spring of relay 113, and through resistance lamp 115 to the positive pole of booster-battery. When ground is disconnected from the brush of interrupter 228, one-half second after relay 108 operates, relays 113 and 109 and meter

112 are released. No further operation of meter 112 is possible since relay 108 is locked under control of sleeve relay 105. Relays 113 and 108, as controlled by interrupter drums 227 and 228 prevent the false operation of the calling subscriber's meter in case relay 104 is temporarily operated in response to a line or trunks busy signal. The release of relay 113 extends the connection from sleeve conductor 127 to ground at the outer right front contact of relay 105.

When the connection is released at the calling station, the holding ground potential is disconnected from sleeve conductor 129 to cause the release of relay 105 and the return of selectors S—1 and S—2 to normal; and when the receiver is replaced at the called station, the connector C—1 returns to normal, the return of the selector and connector switches being effected in well-known manner. The release of relay 105 causes the release of relays 108 and 107 and the return of the line finder LF—1 to normal.

If the called station is not in the same office as the calling station A, the connection from the calling line is extended through brushes 121 and 122 of selector S—1 over trunk 138, through back contacts of relay 205 to the windings of line relay 201 of repeater R—1. The operation of relay 201 closes a circuit for operating the slow-to-release relay 202. Relay 202 connects ground through its inner left front contact over conductor 239, through the outer left back contact of relay 205 and the back contact of the continuity spring of relay 203, over sleeve conductor 219, to brush 123 of selector S—1 to hold the selector and thence to sleeve conductor 129 to operate relay 105 of trunk CT. Relay 106 is marginal and does not operate when ground is connected to conductor 129. The operation of relay 105 connects ground to conductor 127 to hold the line finder LF—1 and to hold the cut-off relay 107. The aforementioned operation of relay 202 also closes a circuit for operating relay 203, closes a bridge across the conductors of trunk T—1 to operate the line relay (not shown) of the distant incoming selector S—3, and closes circuits for energizing the right winding of each of relays 204 and 206. The circuit for operating relay 203 is traced from ground at the outer left front contact of relay 202, through the outer right back contact of relay 205, and through the winding of relay 203 to battery. The bridge across the conductors of trunk T—1 is traced from conductor 252 through the left front contact of relay 201, lower winding of impedance coil 217, inner left back contact of relay 205, left winding of relay 204, back contact of relay 208, outer right front contact of relay 202 to conductor 251. Relay 204 does not operate at this time since the current through the left winding of this relay is electromagnetically opposed to the current through its right winding. The circuit through the right winding of relay 206 includes resistance 226 and, being marginal, relay 206 is not operated at this time.

The line relay 201 of repeater R—1 responds to each of the impulses created by the dialing of the second and succeeding digits of the called subscriber's number, the opening and closing of its left front contact being effective to repeat the impulses over trunk T—1 to control the selective operation of the incoming selector S—3, the intermediate selectors, if any, and the final selector C—2 to establish connection with the called line leading to the called station C. The alternate release and reoperation of relay 201 in

response to the train of impulses created by the dialing of the second digit of the called subscriber's number is also effective to cause the advance of register switch J—1 to a corresponding position which is indicative of the zone in which the called line is located with respect to the calling line. If more than the first two digits were required to finally determine the zone in which the called line is located, the register switch might readily be modified by anyone skilled in the art to respond to any required number of digits. The release of relay 201 in response to the first impulse of the second digit closes a circuit for operating relay 208 and a circuit for operating the stepping magnet 210 of switch J—1 and relay 209 in series. Relays 208 and 209 are both slow in releasing and remain operated until relay 201 reoperates after responding to the last impulse of the digit. With relay 208 operated, the bridge across the trunk T—1 is changed to exclude the lower winding of impedance coil 217 and the left winding of relay 204 and thereby improve the transmission of dial impulses over trunk T—1. The operation of magnet 210 advances the brushes of switch J—1 into the first off-normal position. The off-normal contacts 214 are actuated as soon as the switch is moved out of normal position, the circuit for operating magnet 210 and relay 209 being thereby changed to include the front contact of relay 209 instead of the lower contacts of springs 214. Each succeeding release and reoperation of relay 201 in response to the impulses created by the dialing of the second digit causes a corresponding operation and release of magnet 210, the brushes of switch J—1 being thereby advanced step-by-step into the position corresponding to the second digit. After all of the impulses in the train have been received by relay 201, relays 208 and 209 release and the response of relay 201 to the succeeding trains of dial impulses is ineffective to cause the further advance of switch J—1.

The terminals of bank 211 of switch J—1 may be connected to the brushes of interrupter drums 232, 233, 234 and 235 as required for any particular trunking system. As shown in Fig. 2 the off-normal terminals 1, 6, 7, 8, 9 and 0 of bank 211 are not connected to any of the interrupter drums, the selection of one of these terminals indicating a call to an office in zone 1; off-normal terminal 2 is connected to interrupter drum 232, the selection of terminal 2 indicating a call to zone 2; off-normal terminal 3 is connected to interrupter drum 233, the selection of terminal 3 indicating a call to zone 3; off-normal terminal 4 is connected to interrupter drum 234, the selection of terminal 4 indicating a call to zone 4; and off-normal terminal 5 is connected to interrupter drum 235, the selection of terminal 5 indicating a call to zone 5.

After the succeeding digits of the called subscriber's number have been dialed and connection completed with the called line, the called station is signaled in usual manner; and when the receiver is removed thereat, the current over the conductors of trunk T—1 is reversed in well-known manner, thereby causing the operation of relay 204 of repeater R—1. Relay 204 closes a circuit for operating relay 205. Relay 205 interchanges the connections between the talking conductors of trunk 138 and the windings of relay 201 so that the circuit over these conductors and through the windings of polarized relay 104 of trunk CT—1 is reversed and polarized relay 104

is operated. With relays 204 and 205 both operated, the supervisory bridge across the conductors of trunk T—1 is traced from conductor 251, through the outer right front contact of relay 202, right front contact of relay 204, left winding of relay 204, inner left front contact of relay 205, both windings of retard coil 217, left front contact of relay 201, to conductor 252. The high impedance of this bridge improves the transmission of speech current through condensers 240. The operation of relay 205 also closes a circuit for operating relay 218; this circuit is traced from battery through the winding of relay 218, right front contact of relay 203, outer right front contact of relay 205, to ground at the outer left front contact of relay 202. The operation of relay 205 also causes the release of relay 203 and the release of relay 203 opens the operating circuit for relay 218. Since relay 203 is slow in releasing, the incoming sleeve conductor 219 is momentarily connected through the left front contact of relay 203 and the left front contact of relay 218 to the positive pole of booster-battery 220, the current over conductor 219 being thereby increased sufficiently to cause the operation of marginal relay 106 of trunk CT—1. With relays 203 and 218 released the sleeve conductor 219 is connected through the back contact of relay 203, outer left front contact of relay 205, right back contact of relay 218, left winding of relay 206, over conductor 239 to ground at relay 202. The current in this circuit through the left winding of relay 206 is electromagnetically opposed to the current through the right winding of relay 206 and relay 206 does not operate. The aforementioned operation of relay 106 of trunk CT—1, due to the momentary connection of booster-battery potential to conductor 219, is effective to short-circuit resistance 116 so that the current through the winding of relay 106 in series with the left winding of relay 206 is sufficient to hold relay 106 operated.

The aforementioned operation of relay 106 also closes a circuit for operating group relay 300 which is common to all of the trunk finders such as TF having access to the trunk CT—1. Relay 300 closes a circuit for operating the start relay of the first idle trunk finder in the group and connects ground through its right front contact to the commutator segment of each of the trunk finders which corresponds to the level of the bank to which the trunk CT—1 is connected. Assuming the trunk finder TF to be the first idle finder in the group, the start relay 305 is operated; and assuming the trunk CT—1 to be connected to terminals in the eighth level of the bank, ground is connected to the eighth off-normal segment of the vertical commutator 307. The operation of relay 305 closes a circuit for operating stepping relay 310; this circuit is traced from battery at the middle right back contact of relay 315, through the left winding of relay 310, back contacts of the rotary-stepping magnet 312 and vertical-stepping magnet 311, to ground at the outer right front contact of relay 305. The operation of relay 310 closes a circuit for operating the vertical-stepping magnet 311; this circuit is traced from battery at the middle right back contact of relay 315, through the winding of magnet 311, left back contact of relay 313, front contact of relay 310, to ground at relay 305. The operation of magnet 311 steps the brushes 301, 302, 303 and 304 up to the first level of the bank and commutator brush 308 into engagement with the first-off-normal segment of the vertical com-

mutator 307. The vertical-off-normal springs 319 are actuated as soon as the shaft is moved out of normal position, closing a circuit for operating relay 318; this circuit is traced from battery through the winding of relay 318; left back contact of relay 314; left front contact of relay 305, to ground at the upper front contact of the off-normal springs 319. If the terminals to which trunk CT—1 is connected are not located in the first level of the bank, the operation of magnet 311 causes the release of relay 310; and the release of relay 310 causes the release of magnet 311. Relay 310 and magnet 311 cooperate to elevate the brushes step-by-step in like manner until commutator brush 308 encounters the terminal which marks the level to which the trunk CT—1 is connected; at which time relay 310 is held operated and relay 313 operated by the current in a circuit traced from ground at the right front contact of group relay 300, through the eighth off-normal segment of commutator 307 and brush 308, left winding of relay 313, back contact of rotary-stepping magnet 312, left winding of relay 310, to battery at the middle right back contact of relay 315. In operating, relay 313 closes a holding circuit from battery at the middle right back contact of relay 315, through the winding of vertical-stepping magnet 311, right winding and front contact of relay 313, to ground at relay 305. Magnet 311 is insufficiently energized by the current in this circuit to cause further vertical-stepping. Relay 313 also closes a circuit from battery through the winding of the rotary-stepping magnet 312, left front contact of relay 313, front contact of relay 310, to ground at relay 305. The operation of magnet 312 rotates the brushes into engagement with the first set of terminals in the level in which trunk CT—1 is connected. The circuit through the left windings of relays 310 and 313 is opened at commutator brush 308 due to the rotation of the brush shaft. If the set of terminals to which trunk CT—1 is connected is not the first set in the level, the operation of magnet 312 causes the release of relay 310 and the release of relay 310 causes the release of magnet 312. Relay 310 and magnet 312 thereupon cooperate to rotate the brushes step-by-step until the brushes engage the terminals to which the trunk CT—1 is connected; at which time a circuit is closed from battery through the winding of relay 110 of trunk CT—1, outer left front contact of relay 106, inner right-front contact of relay 105, terminal with which test brush 304 of finder TF is in engagement, left winding of relay 314, outer right back contact of relay 315, conductor 309, right winding of relay 310, to ground at the inner right front contact of relay 305. Relay 110 is operated, relay 310 is held operated, and relay 314 is sufficiently energized by the current in this circuit to close its inner right front contact. Relay 314 is thereupon completely operated by the current in a circuit from battery through its right winding and inner right front contact, through the front contact of rotary-stepping magnet 312 and front contact of relay 310, to ground at relay 305. The complete operation of relay 314 closes a circuit for operating relay 315; this circuit is traced from battery through the left winding of relay 315, outer right front contact of relay 314, to ground at the upper front contact of the off-normal springs 319. The aforementioned operation of relay 110 causes the release of relays 106 and 300. The operation of relay 315 opens the circuit through the left wind-

ing of relay 314 and closes a temporary holding circuit for relay 110; this circuit is traced from battery through the winding and inner left front contact of relay 110; inner right front contact of relay 105, terminal and brush 304 of finder TF, inner left front contact of relay 314, to conductor 309, thence through the outer right front contact of relay 315 and winding of relay 316 in parallel with the right winding of relay 310, to ground at the inner right front contact of relay 305. Relay 316 operates to temporarily hold relay 305 operated. With relays 110 and 314 operated, the cut-off relay 107 of line 100 and the holding relay (not shown) of line finder LF—1 are held operated over conductor 127, through the left front contact of relay 105, inner right back contact of relay 108, impedance 111, inner right front contact of relay 118, terminal and brush 303 of finder TF, middle right front contact of relay 314, over conductor 324 to ground at the back contact of relay 430 of zone metering control unit Z—1.

With the brushes of trunk finder TF in engagement with the set of terminals to which trunk CT—1 is connected, a circuit is closed for indicating to the repeater R—1 that the zone metering control unit Z—1 has been connected to trunk CT—1; this circuit is traced from booster-battery 440 in control unit Z—1, through the front contact of slow-to-release relay 318, outer left front contact of relay 314, brush 302 and terminal of finder TF, sleeve conductor 129 and brush 123 of selector S—1, conductor 219, back contact of relay 203, outer left front contact of relay 205, right back contact of relay 218 and through the left winding of relay 206, over conductor 239 to ground at the inner left front contact of relay 202. Relay 206 is sufficiently energized by the current in this circuit to close its inner right front contact and the operation of this relay is thereupon completed by the energization of its right winding in an obvious circuit. Relay 206, when completely operated, connects the brush of interrupter drum 229 to brush 212 of switch J—1 and connects the sleeve conductor 219 through the right back contact of relay 215 and the left front contact of relay 206 to conductor 239, thereby short-circuiting the left winding of relay 206, relay 206 being held operated by the energization of its right winding.

The aforementioned operation of relay 314 also causes the release of relay 318. The release of relay 318 opens the connection between booster-battery 440 and conductor 129 and closes a circuit from battery through the winding of relay 401 of control unit Z—1 in parallel with the winding of relay 406, over conductor 400, through the back contact of relay 318, outer left front contact of relay 314, brush 302 and terminal of finder TF, over sleeve conductor 129, through brush 123 of selector S—1, conductor 219 of repeater R—1, right back contact of relay 215, left front contact of relay 206, over conductor 239 to ground at relay 202. Relay 401 is operated by the current in this circuit but relay 406 is marginal and does not operate at this time. With relay 401 operated, ground is connected through its inner right front contact to conductor 309, thereby short-circuiting the winding of relay 316 and the right winding of relay 310, and ground is further connected over conductor 309, through the inner left front contact of relay 314, brush 304 and terminal of finder TF, inner right front contact of relay 105, and through the inner left front contact of relay 110 to hold relay 110 op-

erated. The release of relay 316 causes the release of relay 305 and the release of relay 305 causes the release of relay 313 and magnet 312. With relay 315 operated, the start lead from group relay 300 is extended over conductor 330 to the next trunk finder in the group. After relay 305 releases, relay 314 is held operated by the energization of its right winding in a circuit traced through its inner right front contact, over conductor 409 of control unit Z-1 to ground at the outer right front contact of relay 401.

As soon after relay 206 of repeater R-1 is operated, due to the interconnection of trunk CT-1 with control unit Z-1, as the brush of interrupter drum 229 is connected to ground, relay 215 is operated if the called line is outside of zone 1; the circuit for operating relay 215 is traced from battery through its winding and left back contact, outer left back contact of relay 216, back contact of relay 209, off-normal terminal and brush of bank 212 of switch J-1, outer right front contact of relay 206, to ground through interrupter drum 229. Relay 215 opens its operating circuit but is held operated through the left front contact of relay 215, brush and engaged terminal of bank 211 of switch J-1, to ground through the associated one of interrupter drums 232, 233, 234 and 235. The operation of relay 215 closes a circuit for operating relay 216 and relay 216 locks through its right front contact and the left front contact of relay 206, over conductor 239 to ground at relay 202. If the called line is in zone 1, relays 215 and 216 are not operated; but if the called line is in one of zones 2, 3, 4 or 5, the operation of relays 215 and 216 closes and a circuit from booster-battery 220, through the left front contact of relay 216, outer right front contact of relay 215, conductor 219, brush 123 of selector S-1, conductor 129, terminal and brush 302 of trunk finder TF, outer left front contact of relay 314, back contact of relay 318 and over conductor 400 to cause the operation of marginal relay 406 of zone metering control unit Z-1. Relay 406 closes, at its front contact, a connection from the brush of interrupter drum 230, through the left back contacts of relays 404, 403, 402 and 408, and through the inner right back contact and winding of relay 407 to battery. As soon thereafter as the brush of interrupter drum 230 is connected to ground, relay 407 operates and locks solely under the control of drum 230. The operation of relay 407 causes the release of relay 406 and the release of relay 406 causes the operation of relay 402; the circuit for operating relay 402 is traced from battery through its winding and right back contact and through the left front contact of relay 407 to ground at the back contact of relay 406. Relay 402 locks, over conductor 409, to ground at the outer right front contact of relay 401 and connects ground through its inner right front contact to terminal 4 of bank 422 of metering switch M-1. At the end of the first .25 second closure through interrupter drum 230, relay 407 releases, thereby again connecting the winding of relay 406 to conductor 400. If the call is one to zone 2, the holding circuit for relay 215 of repeater R-1 is opened at interrupter drum 232 so that relay 215 releases at the same time that relay 407 releases, to prevent the further operation of relay 406, but if the call is one beyond zone 2, relay 215 is held operated after relay 407 releases so that relay 406 is reoperated in the circuit which includes booster-battery 220 as hereinbefore traced. As soon after the second

operation of relay 406 as the brush of drum 230 is again connected to ground, relay 408 is operated by the current in a circuit traced from the brush of drum 230, through the front contact of relay 406, left back contacts of relays 404 and 403, left front contact of relay 402, outer right back contact of relay 407, and through the inner right back contact and winding of relay 408. Relay 408 locks through its right front contact solely under the control of drum 230. The operation of relay 408 causes the release of relay 406 and the release of relay 406 causes the operation of relay 403. Relay 403 locks over conductor 409 and connects ground to terminal 6 of bank 422 of switch M-1. At the end of the 15 second .25 second closure through interrupter drum 230, relay 408 releases, thereby again connecting the winding of relay 406 to conductor 400. If the call is one to zone 3, the holding circuit for relay 215 of repeater R-1 is opened 20 at interrupter drum 233, and relay 215 releases at the same time that relay 408 releases, to prevent the further operation of relay 406, but if the call is beyond zone 3, relay 215 is held operated after relay 408 releases so that relay 406 25 is operated a third time in the circuit from booster-battery 220. As soon after the third operation of relay 406 as the brush of drum 230 is again connected to ground, relay 407 is reoperated by the current in a circuit which includes 30 the front contact of relay 406, the left back contact of relay 404, the outer left front contact of relay 403, and the left back contact of relay 408. Relay 407 again locks directly under the control of drum 230 and causes the release of relay 406. 35 The release of relay 406 closes a circuit for operating relay 404, which circuit includes the inner right front contact of relay 403, the left front contact of relay 407 and the back contact of relay 406. Relay 404 locks over conductor 409 40 and connects ground to terminal 8 of bank 422 of switch M-1. At the end of the third .25 second closure through interrupter drum 230, relay 407 releases, thereby again connecting the winding of relay 406 to conductor 400. If the call is 45 one to zone 4, the holding circuit for relay 215 of repeater R-1 is opened at interrupter drum 234 and relay 215 releases, at the same time that relay 407 releases, to prevent the further operation of relay 406; but if the call is beyond zone 4, 50 relay 215 is held operated after relay 407 releases so that relay 406 is operated a fourth time in the circuit from booster-battery 220. As soon after the fourth operation of relay 406 as the brush of drum 230 is again connected to 55 ground, relay 408 is reoperated by the current in a circuit which includes the front contact of relay 406, the left front contact of relay 404, the outer right back contact of relay 407. Relay 408 again locks directly under the control of drum 60 230 and causes the release of relay 406. Relay 406 closes a circuit for operating relay 405; this circuit includes the inner left front contact of relay 404, the left front contact relay 408 and the back contact of relay 406. Relay 405 locks 65 over conductor 409 and connects ground to terminal 10 of bank 422 of switch M-1. The release of relay 408 when the fourth closure through drum 230 is ended again connects the 70 winding of relay 406 to conductor 400, but since the repeater R-1 is arranged for use in a system having but five zones, the holding circuit for relay 215 opened at interrupter drum 235 and relay 215 releases at the same time that relay 75

408 releases so that there is no further operation of relay 406.

The zone within which the called line is located having been registered in the zone metering control unit Z—1 by the operation of none, one, two, three or four of the register relays 402, 403, 404 and 405, the unit Z—1 is prepared to control the operation of the calling subscriber's meter accordingly. With relay 104 of trunk CT—1 operated due to the reversal of the current through its windings in response to the answer of the called subscriber as hereinbefore described and with the brushes of trunk finder TF in engagement with the set of terminals to which trunk CT—1 is connected, a circuit is closed for operating relay 317; this circuit is traced from battery through the winding of relay 317, brush 301 and terminal of finder TF, front contact of relay 104, to ground at the outer right front contact of relay 110. As soon thereafter as the brush of interrupter drum 227 is connected to ground, a circuit is closed from this ground, through the back contact of relay 411, outer left back contact of relay 412, front contact of relay 317, right back contact of relay 412, and through the right winding of relay 411 to battery. Relay 411 is operated by the current through its right winding, thereby connecting its left winding and the winding of relay 412 through the left front contacts of relay 411 to the brush of interrupter drum 228. When the brush of drum 228 is connected to ground, approximately two seconds after relay 411 is operated, relay 412 operates and relay 411 is held operated by the energization of its left winding. Relay 412 locks over conductor 409, independent of drum 228; but relay 411 releases when the closure through drum 228 terminates. Relay 412 closes a circuit for operating relay 413; this circuit is traced from battery, through the winding of relay 413, outer left front contact of relay 412, front contact of relay 317, and through the outer right front contact of relay 412 to ground. Relay 413 locks in a circuit through its left front contact, brush and terminals 1 to 10, inclusive, of bank 424 of switch M—1 to ground at the outer right front contact of relay 401. Relay 413 closes a holding circuit for relay 401 and closes a connection from the winding of relay 414, through the inner left front contact of relay 401, inner right front contact of relay 412, terminal 1 and brush of bank 421 of switch M—1, outer left front contact of relay 401, brush and terminal 1 of bank 425 of switch M—1, outer right front contact of relay 413, to the brush of interrupter drum 415. The brush of interrupter drum 415 is connected to ground for .5 second once every second, and, as soon after relay 413 operates as the connection through drum 415 is closed, relay 414 is operated. The operation of relay 414 closes a circuit for operating the stepping magnet 420 of switch M—1. When the closure through drum 415 terminates, the release of relay 414 causes the release of magnet 420. The release of magnet 420 advances the brushes of switch M—1 out of position 1 into engagement with terminal 2 in each of its banks. The switch M—1 continues to advance under the control of interrupter drum 415 from position 2 into position 11. The circuit for operating magnet 420 in each of positions 2, 4, 6, 8 and 10 is traced from the winding of magnet 420 through its interrupter contacts, terminal 2, 4, 6, 8 or 10 and brush of bank 421, outer left front contact of relay 401, brush and corresponding terminal

of bank 425, and through drum 415 to ground. The release of magnet 420 due to the opening of its interrupter contacts in each of these positions, advances the brushes to the next succeeding position. The operation of magnet 420 in each of positions 3, 5, 7 and 9 depends upon the operation of the stepping relay 414, and the circuit for operating relay 414 in each of these positions is traced through the inner left front contact of relay 401, terminal 3, 5, 7 or 9 and brush of bank 421, outer left front contact of relay 401, brush and corresponding terminal of bank 425, and through drum 415 to ground. The switch M—1 is thus advanced two steps for each closure through drum 415 until position 11 is reached. After reaching position 11, stepping relay 414 is operated once every thirty seconds under control of interrupter drum 416, the brush of drum 416 being connected to ground once every thirty seconds. The circuit for operating relay 414 is traced from its winding through the inner left front contact of relay 401, each of terminals 11 to 21, inclusive, and brush of bank 421, outer left front contact of relay 401, brush and corresponding one of terminals 11 to 21, inclusive, of bank 425, to the brush of drum 416. With switch M—1 in position 22, a circuit is closed through brushes 421 and 425 for operating relay 419. Relay 419 locks over conductor 409 and closes a circuit for operating magnet 420; the opening of its operating circuit at its own contacts releases magnet 420 to advance switch M—1 to normal position. The advance of switch M—1 has, therefore, if uninterrupted until the first cycle of rotation is completed, measured off a period of time of from five to five and one-half minutes, five minutes being the unit for which the first charge is made.

While the switch M is being advanced from position 1 to position 11, relay 430 is operated one or more times to cause the operation of the calling subscriber's meter. On a call to zone 1, relay 430 is operated but once, and that in position 2 of switch M—1; on a call to zone 2, relay 430 is operated twice, once in each of positions 2 and 4; on a call to zone 3, relay 430 is operated three times, once in each of positions 2, 4 and 6; on a call to zone 4, relay 430 is operated four times, once in each of positions 2, 4, 6 and 8; and on a call to zone 5, relay 430 is operated five times, once in each of positions 2, 4, 6, 8 and 10. Each operation of relay 430 closes a circuit for operating meter control relay 109. With relay 109 operated, a circuit is closed from booster-battery 440, through the right front contact of relay 430, conductor 324, middle right front contact of relay 314, brush 303 and terminal of finder TF, inner right front contact of relay 110, impedance 111, inner right back contact of relay 108, left front contact of relay 105, sleeve conductor 127, brush 103 of line finder LF—1, front contact of cut-off relay 107, a front contact of relay 109, and through the winding of meter 112 to the negative pole of battery. The meter 112 is thus operated to register one charge for each operation of relay 430. If the call is released before switch M—1 completes its first cycle, relay 413 holds relay 401 until the charging operation is completed, that is, until switch M—1 has advanced beyond position 10. If the connection is continued after the first measured unit of five minutes, the continued operation of relay 401 causes switch M—1 to start a new cycle of operation and repeat the operation of relay 430 and meter 112 as described. On the

second and succeeding cycles the magnet 420 of switch M—1 is immediately operated in position 21 to advance the switch to position 22 without waiting for the closure through interrupter drum 416, it being unnecessary to allow for an immediate advance from position 1 to position 2 on succeeding cycles as on the first cycle. The circuit for operating magnet 420 in position 21 of succeeding cycles is traced through the brush and terminal 21 of bank 423 to ground at the front contact of relay 419.

When the connection is released by the calling subscriber relay 104 of trunk CT—1 and relay 201 of repeater R—1 release. The release of relay 201 causes the release of relay 202. With relay 201 released, the bridge across the conductors of trunk T—1 is opened thereby releasing the succeeding switches in the completing train in usual manner. The release of relay 202 also causes the release of relays 206 and 216 and the operation of release magnet 213 of switch J—1. The operation of magnet 213 causes the brushes of switch J—1 to be restored to normal, whereupon magnet 213 releases. The release of relay 204, upon opening of the bridge across trunk T—1, causes the release of relay 205. The holding ground is disconnected from sleeve conductor 219 when relay 202 releases, so that relay 105 of trunk CT—1 and relay 401 of control unit Z—1 are both released unless temporarily held while switch M—1 is being advanced beyond position 10. With holding ground potential disconnected from conductor 219 at the repeater, and with relay 413 of control unit Z—1 released, relays 105 and 401 are released and the selector S—1 is restored to normal in usual manner. The release of relay 105 causes the release of the cut-off relay 107, the release of relay 110, and the return of line finder LF—1 to normal in usual manner. The aforementioned release of relay 104 causes the release of relay 317; and the release of relay 401 causes the release of relay 314. The release of relay 314 closes a circuit for operating release magnet 320 of trunk finder TF. When the trunk finder reaches normal, the circuit for energizing magnet 320 and the circuit for holding relay 315 operated are opened at springs 319. If relay 401 releases when switch M—1 leaves position 10 or while switch M—1 is in any of positions 11 to 21, inclusive, the circuit for operating magnet 420 is traced through the inner left back contact of relay 401 and the brush of bank 421, to ground at the outer left back contact of relay 401.

To follow the operation of the system on a call originated at a flat-rate subscriber's station, Fig. 7 should be substituted for Fig. 1. The line 700 is extended by the operation of a line finder LF—2 in usual manner to a trunk CT—2 and an associated first selector S—5. The selector S—5 selectively responds to the first digit dialed to extend the connection to a succeeding local selector S—6 or to a repeater such as R—1. A local call is completed through the switch S—6, intermediate selectors if any, and a connector C—4. On local calls no operation of the subscriber's meter 712 is required and none takes place. Relay 705 operates on all calls as soon as holding ground potential is connected to sleeve conductor 729 but relay 706 is marginal and operates only on an interoffice call in response to the connection of booster-battery 220 in repeater R—1 to conductor 219 when the called subscriber answers, as hereinbefore described. In operat-

ing, relay 706 short-circuits resistance 716 so that relay 706 is held operated over conductors 729 and 219 to ground in repeater R—1 when the booster-battery connection is opened and ground potential is again connected to conductor 219. The operation of relay 706 closes the circuit for operating group relay 300, whereupon an idle zone metering control unit such as Z—1 is associated, by the operation of a trunk finder TF with the charging trunk CT—2 in the manner hereinbefore described. With unit Z—1 connected through finder TF to trunk CT—2, a circuit is closed for operating relay 710; this circuit is traced through the inner right front contact of relay 706, right front contact of relay 705, through brush 304 of trunk finder TF, inner left front contact of relay 314, over conductor 309, to ground at the inner right front contact of relay 401. Relay 710 locks to the same ground. The operation of relay 710 causes the release of relay 706 and closes the circuit over which a signal is transmitted from booster-battery 440 of zone unit Z—1 to operate relay 206 of repeater R—1. After the zone indication has been registered in unit Z—1, switch M—1 is advanced to time the call and operate relay 430 as hereinbefore described. Each operation of relay 430 closes circuits for operating meter control relay 709 and meter 712. Release of the connection is similar to that on a call from a message-rate line.

In a system arranged according to Fig. 8, the repeater R—2 shown in Fig. 5 and zone metering control unit Z—2 shown in Fig. 6 are arranged so as to cause the operative association of an idle zone metering control unit with the charging trunk CT—1 or CT—2 immediately upon extension of a call to the repeater without waiting for the answer of the called subscriber. Assuming a call to have been initiated at station A and the line 100 to have been extended through trunk CT—1 and selector S—1 over trunk 138 to repeater R—2, relay 501 is operated by the energization of its windings in series with the calling line 100. The operation of relay 501 closes a circuit for operating relay 502. Relay 502 closes a circuit through the right winding of relay 504, a circuit through the right winding of relay 506, a circuit for operating relay 503, and closes a bridge across conductors 551 and 552 of outgoing trunk T—2 to operate the line relay (not shown) of the incoming selector S—4 to which the trunk T—2 is connected at its distant end; this bridge is traced from conductor 551 through the outer right front contact of relay 502, back contact of relay 508, left winding of relay 504, inner left back contact of relay 505, lower winding of impedance 517, and left front contact of relay 501 to conductor 552. Relay 504 does not operate at this time since the current through its left winding is electromagnetically opposed to the current through its right winding. Relay 506 is marginal and the energization of its right winding in series with resistance 526 is insufficient to cause its operation. Relay 502 also closes a circuit from ground through its inner left front contact, right back contact of relay 515, left winding and inner left back contact of relay 507, over conductor 519, through brush 123 of selector S—1 to sleeve conductor 129, thence to battery through the winding of relay 105 in parallel with the winding of relay 106. Relays 105 and 507 are operated but relay 106 is marginal and the energization of its winding in series with resistance 116 is insufficient to cause its operation. Relay 507 locks

through its right winding and right front contact under control of relay 502, opens the circuit through its left winding and closes a connection from conductor 519 through the inner left front contact of relay 507, left front contact of relay 503, left back contact of relay 518, right back contact of relay 515 to ground at the inner left front contact of relay 502.

The aforementioned operation of relay 507 also opens the operating circuit for relay 503 but since relay 503 is slow in releasing, a circuit is closed momentarily for causing the operation of relay 518; this circuit is traced from the winding of relay 518, through the right front contact of relay 503, outer left front contact of relay 507 to ground at the outer left front contact of relay 502. When relay 503 releases, relay 518 is released. While both of relays 518 and 503 are operated, a circuit is closed from the positive pole of booster-battery 520 through the left front contacts of relays 518 and 503, inner left front contact of relay 507, over conductor 519 to cause the operation of marginal relay 106 of trunk CT-1. Relay 106 locks and causes the starting of a trunk finder TF to associate an idle zone metering control unit Z-2 with the trunk CT-1 as hereinbefore described. When relay 503 releases, conductor 519 is connected through the inner left front contact of relay 507, back contact of relay 503, right front contact of relay 518, right back contact of relay 515, to ground at the inner left front contact of relay 502, so as to hold relays 105 and 106 operated. When relay 518 also releases, the connection between conductor 519 and ground is changed to include the right back contact of relay 518 and the left winding of relay 506 instead of the right front contact of relay 518. The current through the left winding of relay 506 is electromagnetically opposed to the current through the right winding of relay 506, so that this relay does not operate at this time.

When the trunk finder TF connects the control unit Z-2 to trunk CT-1, in response to the operation of relay 106, relays 110 and 314 are operated as hereinbefore described. The operation of relay 314 closes a circuit from booster-battery 640 of unit Z-2, through the front contact of relay 318, outer left front contact of relay 314, brush 302 of trunk finder TF, over conductor 129, through brush 123 of selector S-1, conductor 519 of repeater R-2, inner left front contact of relay 507, back contacts of relays 503 and 518, left winding of relay 506, right back contact of relay 515, to ground at the inner left front contact of relay 502. The current in this circuit through the left winding of relay 506 is now electromagnetically aiding the current through the right winding of this relay so that relay 506 operates. With relay 506 operated, the sleeve conductor 519 is connected directly through the inner right front contact of relay 506 and right back contact of relay 515 to ground at relay 502, the left winding of relay 506 being short-circuited. Since resistance 526 is short-circuited at the outer right front contact of relay 506, relay 506 is held operated by the energization of its right winding. When relay 318 of trunk finder TF releases, a circuit is closed from ground potential connected to conductor 519, through brush 123 and sleeve conductor 129 of selector S-1, brush 302 of trunk finder TF, outer left front contact of relay 314, back contact of relay 318, over conductor 600, through the windings of relays 601 and 606. Relay 601 operates but relay 606 is marginal and does not operate. Relay 601 connects ground over

conductor 609 to hold relay 314 operated and connects ground to conductor 309 to hold relay 110 of trunk CT-1 operated.

The impulses created by the dialing of the second and succeeding digits of the number of the subscriber's station with which connection is desired are repeated by relay 501 over the trunk T-2 to selectively operate the selector S-4, any intermediate switches and the connector C-3. The release of relay 501 in response to the first impulse for each digit causes the operation of relay 508 and relay 508 remains operated until all of the impulses in a train have been received. With relay 508 operated the bridge across trunk T-2 is traced directly from conductor 551 through the outer right front contact of relay 502, front contact of relay 508, and left front contact of relay 501 to conductor 552. Relay 502 is slow in releasing and remains operated during the response of relay 501 to the 20 dial impulses.

The release of relay 501, in response to the dial impulses for the first digit dialed after the calling line is connected to repeater R-2, also closes a circuit through the lower contact of the rotary off-normal springs 514 for operating rotary-stepping magnet 510 and relay 509. Relay 509 is a slow-to-release relay and remains operated until all of the impulses in the train have been received. The operation of magnet 510 advances the brushes of switch J-2 from normal to the first off-normal position. Springs 514 are actuated when the brushes are moved out of normal position so that the circuit for holding relay 509 and for reoperating magnet 510 is traced through the front contact of relay 509 instead of through the lower contacts of springs 514. The magnet 510 releases when relay 501 reoperates and is reoperated and released under control of relay 501 in response to each of the succeeding impulses in the train. The brushes of switch J-2 are thereby advanced to a position corresponding to the second digit of the called subscriber's number, which digit indicates the zone within which the called line is located. The terminals of bank 511 of switch J-2 are cross-connected to the brushes of interrupter drums 532, 533, 534 and 535 as required. Due to the actuation of springs 514, the response of relay 501 to the succeeding digits is ineffective to cause the further operation of switch J-2.

When relay 509 releases after the setting of switch J-2 and as soon thereafter as the brush of interrupter drum 529 is connected to ground, a circuit is closed, if the called line is located in one of zones 2, 3, 4 and 5, from drum 529 through the middle right front contact of relay 506, brush and off-normal terminal of bank 512 of switch J-2, back contact of relay 509, outer left back contact of relay 516 and through the left back contact and winding of relay 515. Relay 515 operates and closes a circuit for operating relay 516. Relay 516 locks under control of relay 502 and closes a circuit from booster-battery 520, through the left front contact of relay 516, outer right front contact of relay 515, inner right front contact of relay 506, over conductor 519, brush 123 of selector S-1, conductor 129, brush 302 of trunk finder TF, outer left front contact of relay 314, back contact of relay 318, over conductor 600 to the windings of relays 401 and 406. Relay 401 is held operated and relay 406 is operated by the current in this circuit. On a call to zone 1, relays 515 and 516

are not operated; but on a call to zones 2, 3, 4, or 5 relay 515 is locked through its left front contact and brush 511 of switch J—2 to that one of interrupter drums 532, 533, 534 or 535 which is connected to the terminal with which brush 511 is in engagement. Relays 606, 607 and 608 are thereupon operated under control of relays 515 and 516, switch J—2 and interrupter drums 530, 532, 533, 534 and 535, to cause the operation of zone relays 602, 603, 604 and 605 in similar manner to that in which relays 406, 407 and 408 are operated under control of relays 215 and 216, switch J—1 and interrupter drums 230, 232, 233, 234 and 235 to cause the operation of zone relays 402, 403, 404 and 405 as hereinbefore described.

When the called subscriber answers, the current over trunk T—2 is reversed in the usual manner, thereby causing the operation of relay 504, the current through the left winding being then electromagnetically aiding the current through its right winding. The operation of relay 504 causes the operation of relay 505 thereby reversing the current over trunk 138 to operate the polarized supervisory relay 104 of trunk CT—1. The operation of relay 104 closes a circuit from ground at the outer right front contact of relay 110, through the front contact of relay 104 and brush 301 of trunk finder TF to operate relay 317. The operation of relay 317 places relays 611 and 612 under the control of interrupter drums 527 and 528 whereby not less than two seconds elapse before the advance of switch M—2 is initiated, relays 611 and 612 being operated in a similar manner to that in which relays 411 and 412 are operated as hereinbefore described. With relays 601, 612 and 317 operated, the winding of stepping relay 614 is connected through terminal 1 and brush of each of banks 621 and 624 to the brush of interrupter drum 615. The timing switch M—2 is thereupon advanced one cycle per five minutes under the control of interrupters 615 and 616 in similar manner to that in which switch M—1 is advanced under control of interrupters 415 and 416 as hereinbefore described. Relay 630 is operated to cause the operation of relay 109 and meter 112 according to the zone within which the called line is located in like manner to that in which relay 430 controls the metering circuit as hereinbefore described. Relay 619 performs a similar function to that of relay 419 as hereinbefore described.

When the connection is released by the calling subscriber, the repeater R—2 and zone metering control unit Z—2 are restored to normal in similar manner to that in which the repeater R—1 and control unit Z—1 are restored to normal as hereinbefore described. The line finder LF—2, selectors S—1 and S—4 and connector C—3 are restored to normal in usual manner.

What is claimed is:

1. In a multi-office telephone system, subscribers' lines, means including a charging trunk for use in completing a talking connection between a calling one of said lines and any called line, another trunk for use in completing interoffice calls, a meter for registering charges for calls originating over said calling line, zone metering apparatus for controlling the operation of said meter, switching means for operatively associating said zone metering apparatus with said charging trunk, and means associated with said other trunk for transmitting zone indicating signals to said zone apparatus.

2. In a multi-office telephone system, subscribers' lines, means including a charging trunk for use in completing a talking connection between a calling one of said lines and a called line, an outgoing trunk repeater for use in completing interoffice calls, a meter for registering charges for calls originating over said calling line, zone metering apparatus for controlling the operation of said meter, switching means for operatively associating said zone metering apparatus with said charging trunk, and means in said repeater for initiating the operation of said switching means to associate said zone metering apparatus with said charging trunk.

3. In an automatic telephone system according to claim 2, means in said zone metering apparatus responsive to the association of said apparatus with said charging trunk for transmitting a signal to said repeater.

4. In an automatic telephone system according to claim 2, means in said zone metering apparatus responsive to the association of said apparatus and charging trunk for transmitting a signal to said repeater, and means in said repeater for thereupon transmitting to said apparatus signals indicative of the zone to which a call through said repeater is directed.

5. In an automatic telephone system according to claim 2, means in said zone metering apparatus responsive to the association of said apparatus and charging trunk for transmitting a signal to said repeater, means in said repeater for thereupon transmitting to said apparatus signals indicative of the zone to which a call through said repeater is directed, and means responsive to the answer of the called station for initiating the operation of said apparatus to control the operation of said meter in accordance with the zone signals received from said repeater.

6. In a multi-zone telephone system, subscribers' lines and stations in each of a plurality of zones, a calling station, a meter for said calling station, a first selector switch, means including a charging trunk for connecting said first selector switch with the line of the calling subscriber, other selector switches selectable by said first selector for use in completing local calls, outgoing trunks selectable by said first selector for use in completing interoffice calls, meter operating means individual to said charging trunk, zone metering control units for use on interoffice calls, switching means effective upon connection of said charging trunk with an outgoing trunk for connecting an idle one of said control units with said charging trunk, circuit means including a supervisory relay in said charging trunk for rendering the meter operating means in said charging trunk operatively effective on local calls, and means including said supervisory relay in said charging trunk for rendering the connected zone metering control unit operatively effective on an interoffice call in place of the operating means of said charging trunk.

7. In a telephone system, according to claim 6, means associated with each of said outgoing trunks and operatively responsive to the connection of a zone metering control unit with said charging trunk for transmitting to said zone metering control unit signals indicative of the particular zone to which calls over said outgoing trunk are directed.

8. In a multi-zone telephone system, subscribers' lines including a flat-rate subscriber's line, a service meter for said line for registering charges

for all calls except local calls, a first selector switch for use in completing both local and inter-office calls from said line, switching means including a charging trunk for connecting said first selector switch with said flat-rate subscriber's line, other selector switches selectable by said first selector for use in completing local calls, outgoing trunks selectable by said first selector for use in completing interoffice calls, zone metering control units for use on interoffice calls, switching means operative upon connection of said charging trunk with an outgoing trunk for connecting a zone metering control unit with said charging trunk, signal means individual to said outgoing trunk operatively responsive to the connection of said zone metering control unit with said charging trunk for indicating to said control unit the particular zone to which calls over said outgoing trunk are directed, and means individual to said zone metering control unit for causing the operation of said meter one or more times, the number of meter operations being in accordance with the zone in which the called line is located as indicated by the signals received from the repeater connected to said charging trunk.

9. In an automatic telephone system, subscribers' lines including a message-rate line and a flat-rate line, a meter for registering a charge for all calls from said message-rate line, a meter for registering a charge for all calls except local calls from said flat-rate line, means including a message-rate charging trunk and a first selector for use in completing both local and interoffice calls from said message-rate line, means including a flat-rate charging trunk and another first selector switch for use in completing both local and interoffice calls from said flat-rate line, other selector switches selectable by said first selectors for use in completing local calls, outgoing trunks selectable by said first selectors for use in completing interoffice calls, zone metering control units for use in operating said meters on interoffice calls, finder switches, one for each of said zone metering control units, and means in each of said charging trunks operative in response to the selection of an outgoing trunk and inoperative in response to the selection of one of said other selector switches for setting in operation one of said finder switches to connect an idle zone metering control unit with said charging trunk.

10. In a multi-zone telephone system, subscribers' lines including a message-rate line and a flat-rate line, service meters one for each of said lines, means including a message-rate charging trunk and a first selector switch for use in completing both local and interoffice calls from said message-rate line, means including a flat-rate charging trunk and another first selector switch for use in completing both local and interoffice calls from said flat-rate line, other selector switches selectable by said first selectors for use in completing local calls, outgoing trunks selectable by said first selectors for use in completing interoffice calls, meter operating means individual to said message-rate charging trunk, zone metering control units for use on interoffice calls, switching means operative upon connection of either one of said charging trunks with one of said outgoing trunks for connecting an idle one of said zone metering control units with the connected charging trunk, signal means for said one of the outgoing trunks operatively responsive to the connection of said zone metering control unit with the connected charging trunk

for indicating to said control unit the particular zone to which calls over said outgoing trunk are directed, a supervisory relay in each of said charging trunks for operation in response to the answer of the called station, means including the supervisory relay in said message-rate charging trunk for rendering the meter operating means in this charging trunk operatively effective on local calls, and means in said zone metering control unit adapted to cooperate with the supervisory relay in either of said charging trunks for rendering the zone metering control unit operatively effective on interoffice calls.

11. In a multi-office telephone system, subscribers' lines, means including a charging trunk for use on both local and interoffice calls in completing a talking connection between a calling one of said lines and a called line, an outgoing trunk repeater for use in completing interoffice calls, a meter for registering charges for calls originating over said calling line, zone metering apparatus for controlling the operation of said meter, switching means for operatively associating said zone metering apparatus with said charging trunk, and means operative upon the interconnection of said charging trunk and outgoing trunk repeater for initiating the association of said zone metering apparatus with said charging trunk.

12. In a multi-office telephone system, subscribers' lines, means including a charging trunk for use on both local and interoffice calls in completing a talking connection between a calling one of said lines and a called line, an outgoing trunk repeater for use in completing interoffice calls, a meter for registering charges for calls originating over said calling line, zone metering apparatus for controlling the operation of said meter, switching means for operatively associating said zone metering apparatus with said charging trunk, means in said outgoing repeater operative in response to the answer of the called subscriber for initiating the association of said zone metering apparatus with said charging trunk.

13. In a multi-office telephone system, subscribers' lines, means including a charging trunk for use in completing a talking connection between a calling line and a called line, an outgoing trunk repeater for use in completing interoffice calls, a service meter for the calling line, timing and meter operating apparatus for controlling the operation of said meter, switching means for operatively associating said timing and meter operating apparatus with said charging trunk, and means in said repeater for initiating the operation of said switching means to associate said timing and meter operating apparatus with said charging trunk.

14. In a telephone system according to claim 13, means associated with said timing and meter operating apparatus for transmitting to said repeater a signal indicative of the association of said apparatus with said charging trunk.

15. In a telephone system according to claim 13, means associated with said timing and meter operating apparatus for transmitting to said repeater a signal indicative of the association of said apparatus with said charging trunk, and means in said repeater for thereupon transmitting to said apparatus signals indicative of the charging rate for a call from the calling to the called station.

16. In a telephone system according to claim 13, means associated with said timing and me-

ter operating apparatus for transmitting to said repeater a signal indicative of the association of said apparatus with said charging trunk, means in said repeater for thereupon transmitting to said apparatus signals indicative of the charging rate for a call completed through said repeater, and means responsive to the answer of the called station for initiating the operation of said apparatus to operate said meter in accordance with the indicated charging rate.

10 17. In a multi-zone telephone system, subscriber's lines, means including a charging trunk for use in completing a talking connection between a calling line and a called line, an outgoing trunk repeater for use in completing inter-office calls, a service meter for the calling line, meter operating apparatus for controlling the operation of said meter, switching means for op-

eratively associating said meter operating apparatus with said charging trunk, means in said repeater for initiating the operation of said switching means to associate said apparatus with said charging trunk, means in said repeater for thereupon transmitting to said apparatus signals indicative of the charging rate for a call completed through said repeater, means responsive to the answer of the called subscriber for initiating the operation of said meter operating means to operate said meter in accordance with the indicated charging rate, and timing means for measuring unit periods of time during the maintenance of a connection and for controlling said meter operating means in accordance with the duration of the call.

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