

March 24, 1936.

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2,034,846

TELEPHONE SYSTEM

Filed Oct. 11, 1934

5 Sheets-Sheet 1

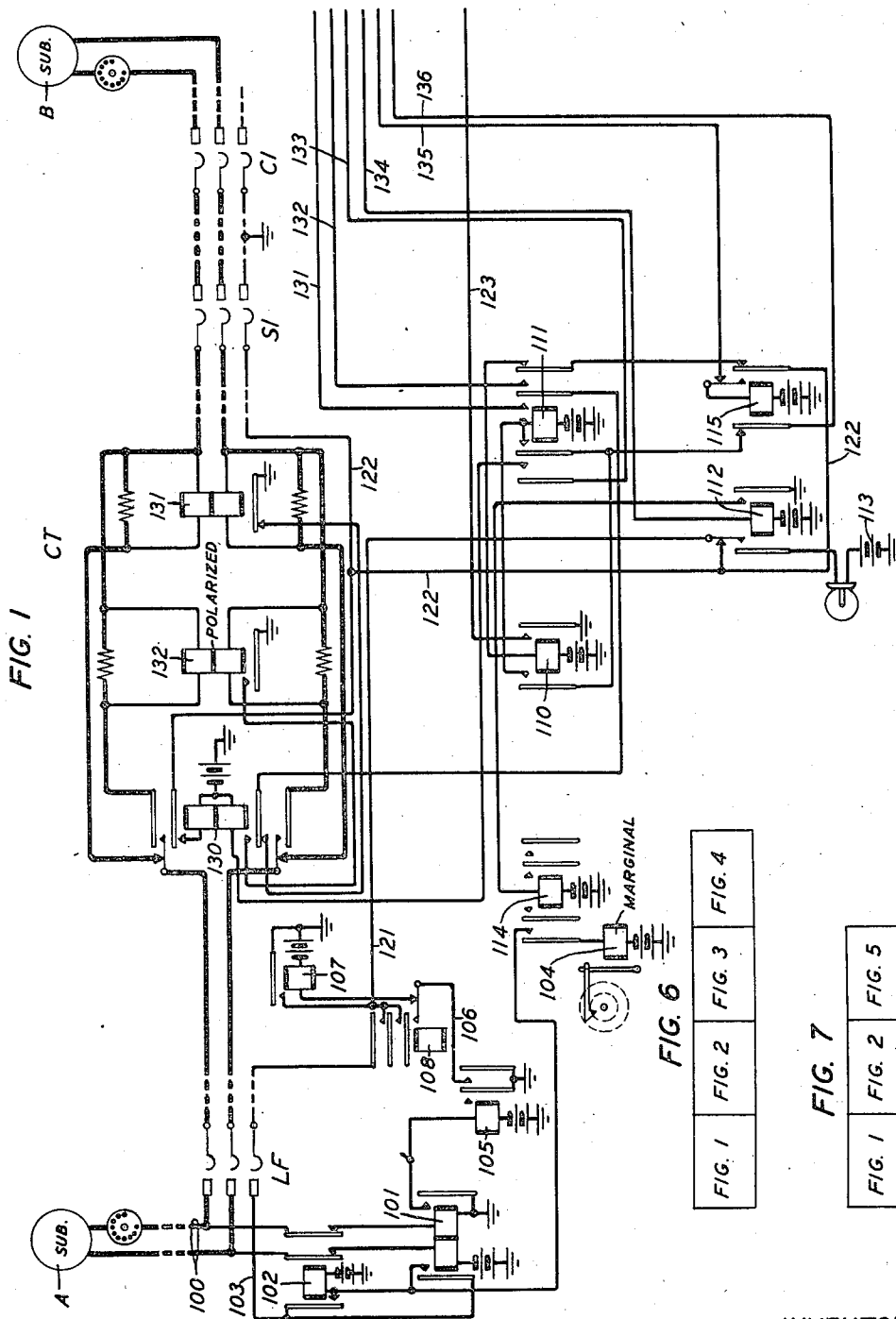


FIG. 1

FIG. 6

FIG. 1	FIG. 2	FIG. 3	FIG. 4
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FIG. 7

FIG. 1	FIG. 2	FIG. 5
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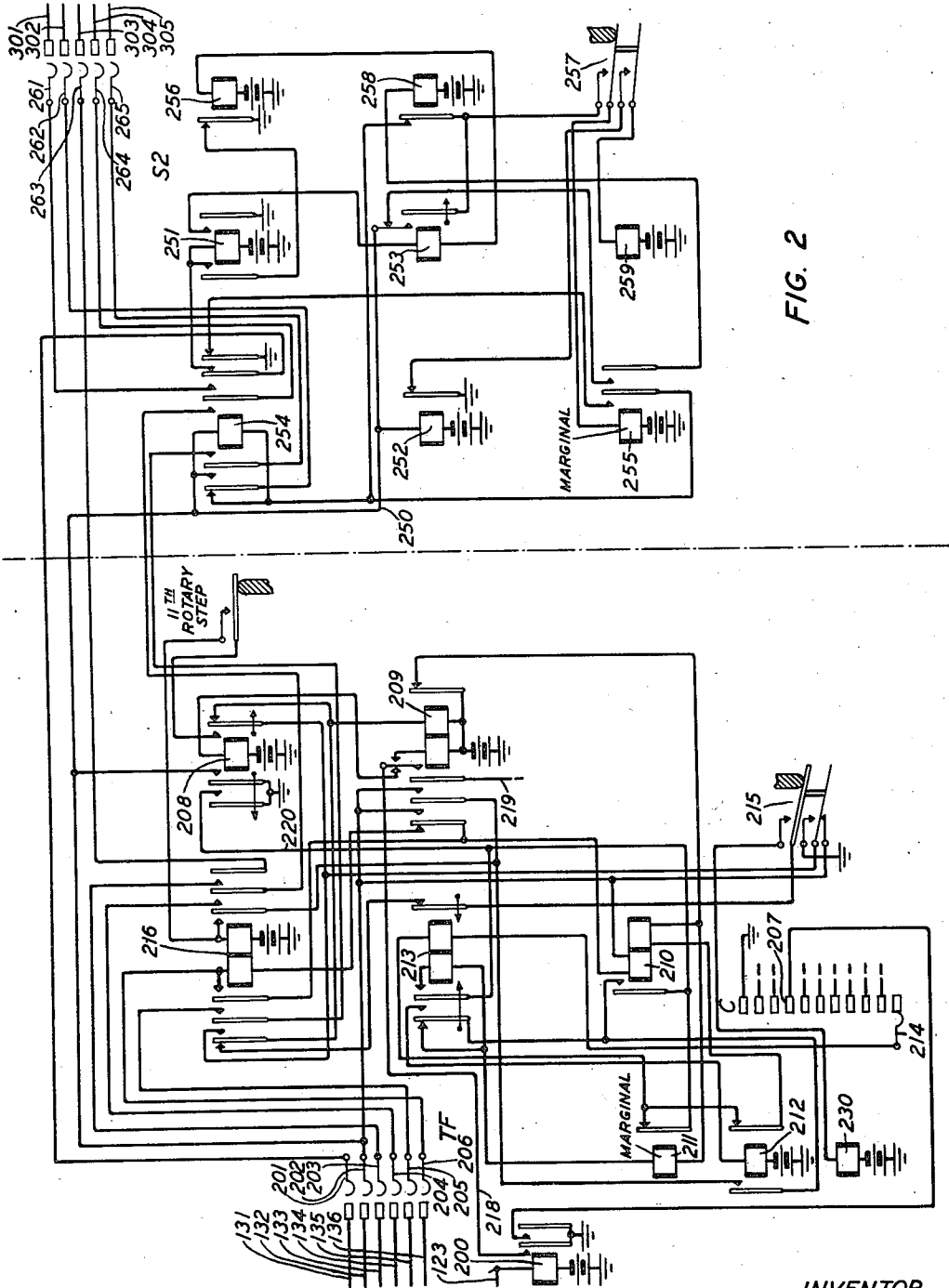


FIG. 2

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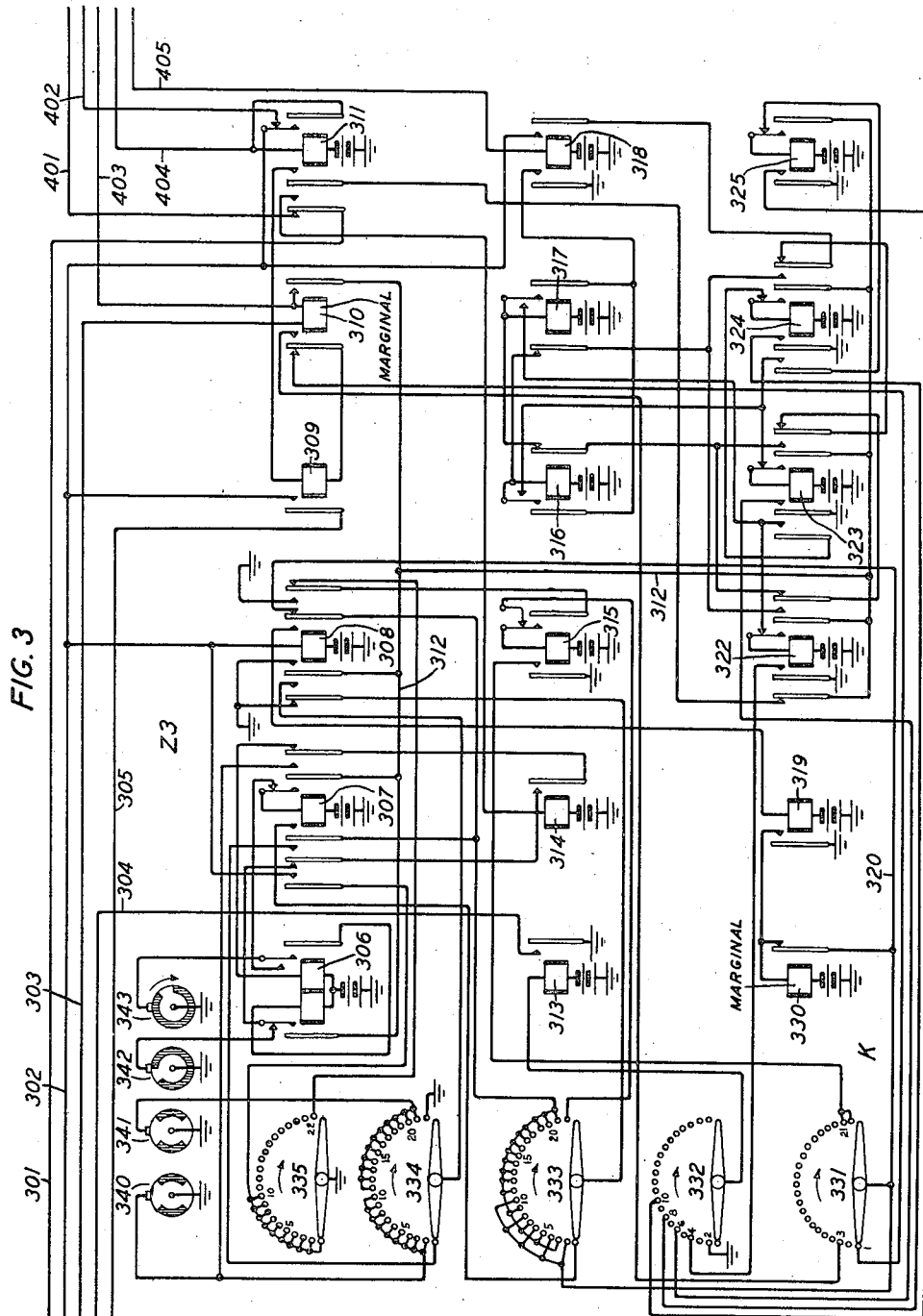
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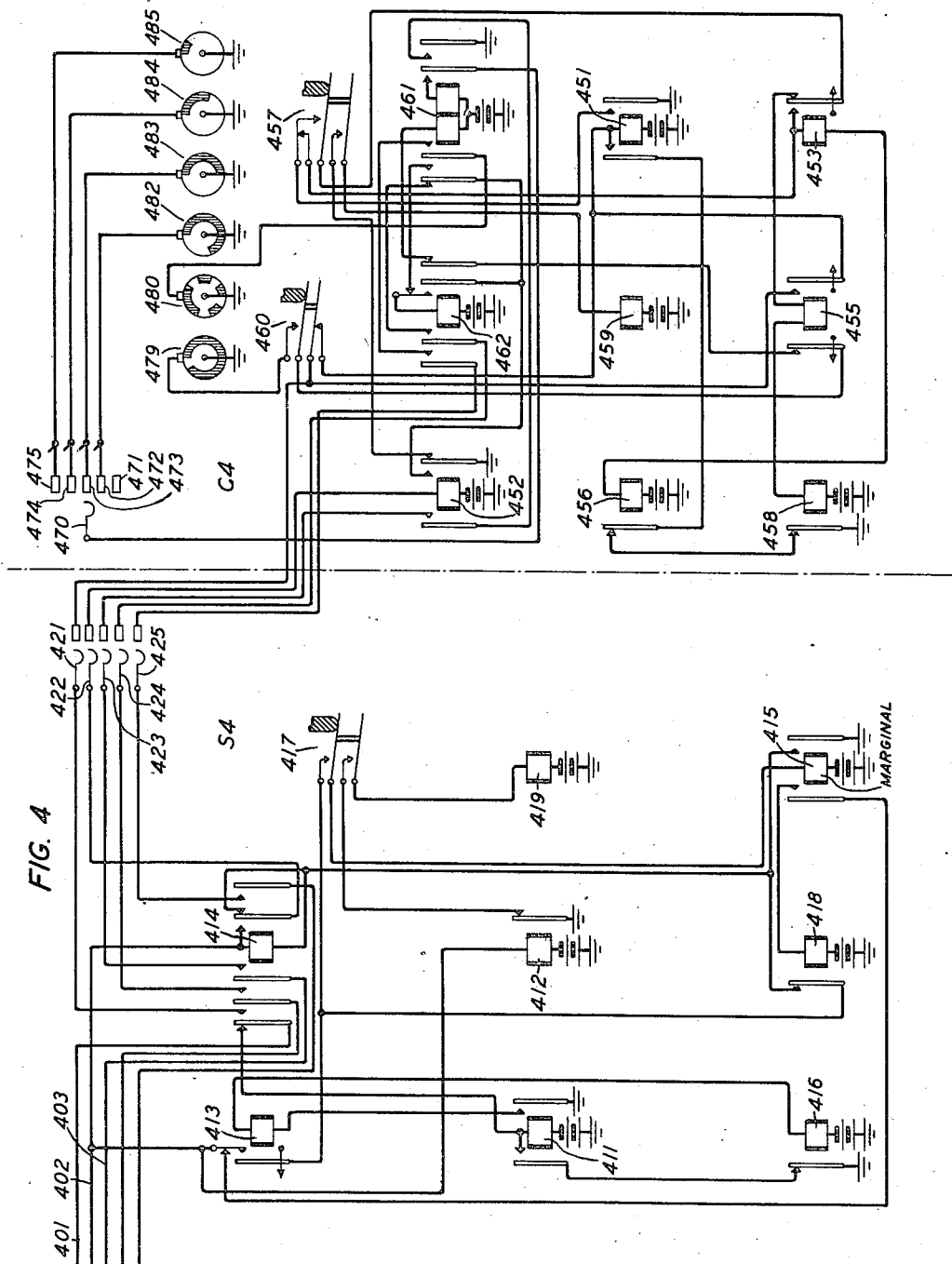
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TELEPHONE SYSTEM

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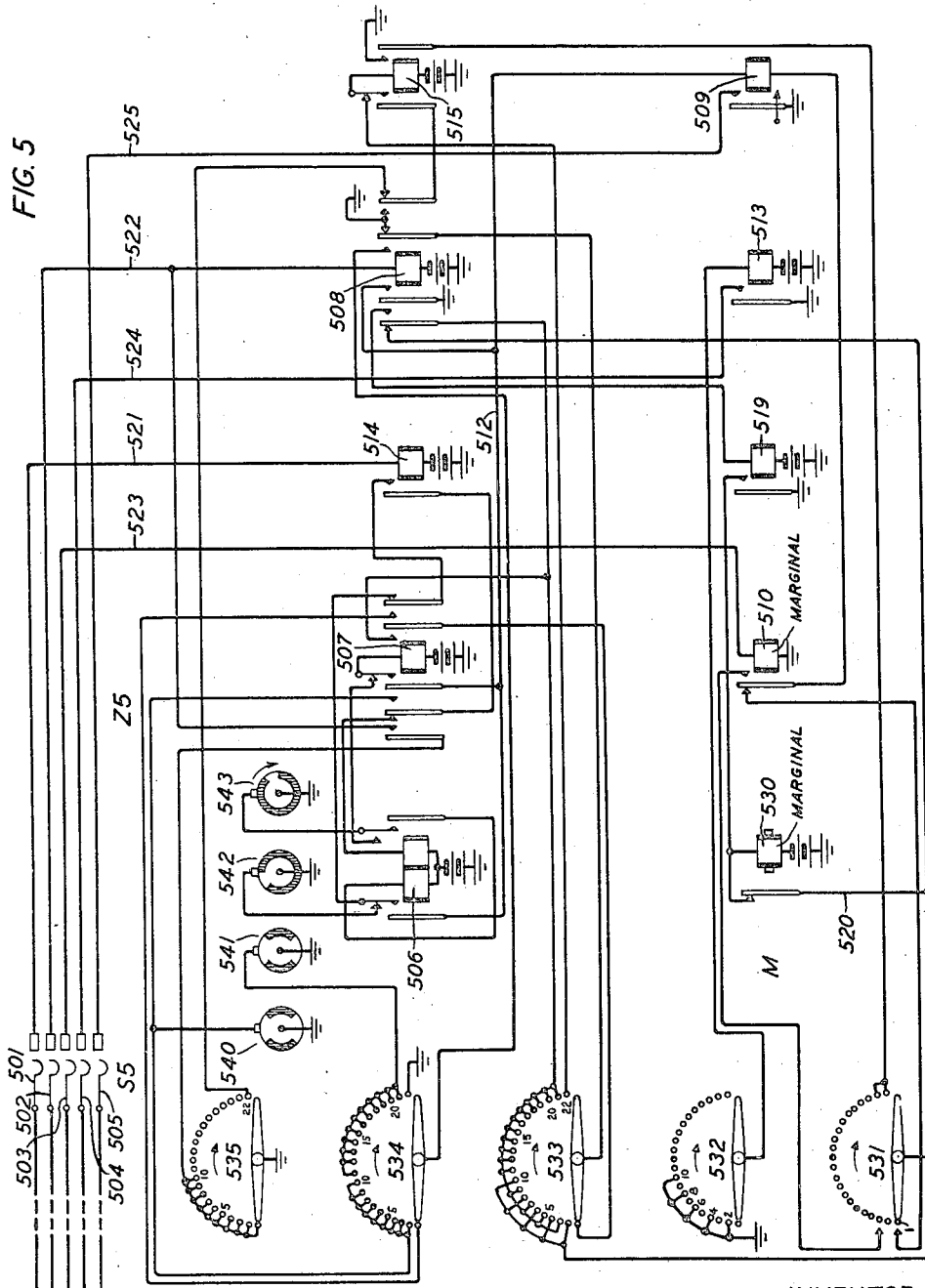
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5 Sheets-Sheet 5



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2,034,846

TELEPHONE SYSTEM

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Application October 11, 1934, Serial No. 747,830

18 Claims. (Cl. 179—7.1)

This invention relates to telephone systems and more 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 zone-metering systems, that is, systems in which the charge registered on a calling subscriber's meter depends upon the location of the called line with respect to the calling line, it has heretofore been known to provide zone apparatus auxiliary to a first selector or to provide zone apparatus auxiliary to an outgoing trunk. In systems employing register senders for controlling the operation of the automatic switching mechanism, zone apparatus has been provided in the register senders for controlling the operation of a calling subscriber's meter.

According to this invention, a system employing switching mechanism directly responsive to directive impulses from a calling subscriber's impulse transmitter, is provided with auxiliary switches for association with a line in response to the initiation of a call thereover, the auxiliary switches being selectively responsive to as many digits of a called number as are required for determining the zone within which the called line is located. The zone-metering apparatus may alternatively be associated with, and individual to, any one of the switches of the zone determining train or selected by the final switch of the zone determining train.

According to a feature of the invention, a finder switch is provided for connecting an associated first auxiliary selector of a zone determining train directly with a calling line or alternatively, and preferably, directly with the trunk leading to the first selector employed in establishing a desired talking connection. A further feature is an arrangement whereby zone-metering apparatus and timing mechanism for repeated charging is provided individual to the first auxiliary selector of the zone determining train, all succeeding switches of the zone determining train being immediately released upon determination of the zone of the called line. On local calls the charging operation is not repeated and a further feature of the invention is the release of the first auxiliary selector switch and the associated finder switch as soon as the required charging operation for a local call has been completed.

A telephone system arranged in accordance with the features of this invention is shown dia-

grammatically in the drawings which comprise seven figures.

Fig. 1 shows subscribers' stations A and B, a line finder LF, an associated charging trunk CT, a selector S1 and a connector C1 for use in completing connections between calling and called lines.

Fig. 2 shows a first auxiliary selector S2 and a trunk finder TF for use in associating the selector S2 with the charging trunk CT of Fig. 1.

Fig. 3 shows a zone metering control apparatus Z3 which is connected to a set of terminals in the bank of the selector S2 of Fig. 2.

Fig. 4 shows a second auxiliary selector S4, individual to the control apparatus Z3 of Fig. 3, and a connector C4 which, together with the selector S2 of Fig. 2, form a zone determining train of switches.

Fig. 5 shows a second auxiliary selector S5 and an alternative zone-metering control apparatus Z5.

Fig. 6 shows how Figs. 1, 2, 3, and 4 are to be arranged with respect to each other to represent one system in which the invention is embodied.

Fig. 7 shows how Figs. 1, 2, and 5 are to be arranged with respect to each other to represent another system in which the invention is embodied.

The line finder switch LF, the trunk finder switch TF, the selector switches S1, S2, S4, and S5, and the connector switches C1 and C4, illustrated in the drawings, are similar in construction and are of the Strowger type. The broken lines represent portions of the circuits which have been omitted because they are not involved in the description of this invention. For a complete description of the construction of Strowger type switches and the operation of such a switch when used as a selector or connector, reference may be had to pages 53 to 67 inclusive of the second edition of "Automatic Telephony" by Smith and Campbell. For a complete description of the operation of a Strowger type switch employed as a line finder, reference may be had to my Patent No. 1,799,654 granted April 7, 1931. The invention is not limited, however, in its application to systems using this particular type of switch nor is it limited to the particular system shown in the drawings.

The selector S1 and connector C1 represent the first and the last of the numerical switches employed in completing a connection between a calling station A and a called station B. As many additional selectors may be inserted between switches S1 and C1 as may be necessary to com-

plete a connection in any particular system. On interoffice or toll calls, one or more impulse repeaters may be included in the connection.

The charging trunk CT comprises the usual polarized supervisory relay 132 whose windings are in series with the talking conductors of the trunk during the talking period, a second relay 131 whose windings are in series with the talking conductors of the trunk during the dialing period, and a switching relay 130 for connecting the windings of relays 131 and 132 to the calling line. Relay 131 responds to and repeats the impulses created by the calling subscriber's dial to control the selection of a zone-metering control unit, such as Z3 shown in Fig. 3, and the operation of a zone determining train such as that comprising the selectors S2 and S4 and the connector C4, shown in Figs. 2, 3, and 4. If the trunk CT is to be used with message-rate subscribers' lines, the lower winding of relay 130 is of low resistance; but if the trunk CT is to be used with flat-rate subscribers' lines, the lower winding of relay 130 is of high resistance.

The zone determining train shown on Figs. 2, 3, and 4 comprises a trunk finder TF, selectors S2 and S4, a connector C4 and associated apparatus for determining the zone in which the called subscriber's line is located, and means for transmitting the zone information to a zone-metering control unit, such as Z3 shown in Fig. 3. The zone-metering control unit Z3 comprises means for registering the zone information received from the zone determining train, a timing switch K for measuring off, during conversation, each unit period for which a charge is to be made, and means for transmitting to the charging trunk CT either one, two, three, four or five impulses for causing the operation of the calling subscriber's meter. The number of impulses transmitted to the charging trunk for each unit period measured by switch K, is dependent on the zone in which the called station is located, as determined by the zone determining train and registered in the control unit Z3. The particular arrangement shown is one in which the called zone is determined by the first four digits dialed. By omitting switches or by adding switches in the zone determining train, the arrangement may be modified for use where the zone is determined by the first digit alone or by any other number of digits. The length of a unit period for which a charge is made may also be dependent upon the zone within which the called line is located, and the first unit period may differ in length from the overtime periods.

The zone determining train shown on Figs. 2 and 5 comprises a trunk finder TF and selectors S2 and S5 for selecting a zone-metering control unit such as Z5 shown in Fig. 5. The control unit Z5, which is arranged to provide the proper charging information for the zone called, comprising a timing switch M for measuring off, during conversation, each unit period for which a charge is to be made, and means for transmitting the charging information to the charging trunk CT for causing the operation of the calling subscriber's meter. The zone-metering control units, such as Z5, are each arranged to transmit ground impulses to the charging trunk CT when the called subscriber answers. The number of ground impulses transmitted to the charging trunk and the length of a unit period of conversation are fixed for each particular zone-metering control unit according to the zone with which the control unit is associated. In the ar-

range comprising Figs. 2 and 5, the zone-metering control unit Z5 is selected in response to the dialing of two digits. If the zone is indicated by a single digit, the selector S5 may be omitted; and if more than two digits are required for determining the called zone, additional selectors may be provided. The particular control unit Z5 shown in Fig. 5, is arranged to transmit five impulses to the charging trunk for each period measured by timing switch M and the periods measured off by switch M are five minutes each, both the initial periods and the overtime periods. The arrangement may be modified so that any desired number of impulses are transmitted and may be modified so that the length of the measured unit periods are of any desired length and may be modified so that overtime periods differ in length from that of the initial period.

In my Patent No. 1,859,941 granted May 24, 1932, there is a table showing six of the many possible charging plans which may be used for areas having five charging zones. The wiring of the arcs of the timing switches K and M of control units Z3 and Z5 depends on the particular plan employed. The switch M of control unit Z5 shown in Fig. 5, is wired to fulfill the requirements for zone 5 of plan 1 of this table; and the switch K of control unit Z3 shown in Fig. 3, is wired to fulfill the requirements for five zones according to plan 1 of the table.

The operation of the system comprising Figs. 1, 2, 3, and 4 will now be described. Upon removal of the receiver at a station A to originate a call, a circuit is closed over line 100 to operate the line relay 101. Relay 101 closes a circuit for operating group relay 105 and connects the winding of cut-off relay 102 over conductor 103 to the sleeve terminal of line 100 in the banks of the line finders having access thereto. Group relay 105 connects ground to conductor 106 to operate the start relay 107 of the first idle line finder in the group. The operation of relay 107 starts the operation of line finder LF in search for the terminals of the line 100 and also connects ground directly to sleeve conductor 121 of trunk CT. Relays 101, 102, 105, 107, and 108 and conductors 103, 106, and 121 correspond to relays 2, 3, 5, 50, and 53 and conductors 4, 6, and 73, respectively, in my aforementioned Patent No. 1,799,654 to which reference may be had for a description of the further operation of line finder LF in extending line 100 to the windings of the line relay (not shown) of selector S1. The connection of ground to sleeve conductor 121 causes the operation of relay 110. Relay 110 connects the winding of relay 111 through the left front contact of relay 110 and left back contact of relay 115 over conductor 136 to mark the terminals associated with trunk CT in the banks of the trunk finders in the group which includes the finder TF. Relay 110 also connects ground over conductor 123 to operate the trunk finder group relay 200. Relay 200 connects ground to the segment of commutator C of trunk finder TF which corresponds to the level in which the charging trunk CT is located. For this disclosure it will be assumed that the charging trunk CT is connected to terminals in the trunk level identified by the segment 207 of commutator C. Relay 200 also closes a circuit for operating the start relay of the first idle trunk finder in the group. This circuit is traced from ground at the inner front contact of relay 200, conductor 218, left back contact of relay 209, through the

winding of start relay 208 to battery. The operation of relay 208 causes the operation of relay 252 of the associated selector S2 and the operation of stepping relay 210. The circuit for operating relay 210 is traced from ground at the outer left front contact of relay 208, conductor 220, back contact of the vertical-stepping magnet 211, back contact of the rotary-stepping magnet 212, through the right winding of relay 210 to battery at the right back contact of relay 209. The stepping relay 210 closes a circuit for operating the vertical-stepping magnet 211, from ground at the outer left front contact of relay 208, conductor 220, front contact of relay 210, left back contact of relay 213, through the winding of magnet 211 to battery at the right back contact of relay 209. The operation of magnet 211 elevates the brush mechanism of the trunk finder TF, consisting of brushes 201, 202, 203, 204, 205, 206, and 214 to a point opposite the trunks of the first level. The movement of the shaft out of normal position actuates the vertical off-normal springs 215. The operation of magnet 211 also opens the operating circuit for stepping relay 210; and, if the terminals to which trunk CT is connected in the back of trunk finder TF are not located in the first level, relay 210 releases thereby causing the release of magnet 211. The release of magnet 211 recloses the operating circuit for relay 210 and the reoperation of relay 210 causes the reoperation of magnet 211, the brushes of finder TF being thereby elevated to a point opposite the trunks of the second level. The interaction of relay 210 and magnet 211 continues until the brushes reach the level containing the charging trunk CT at which time a circuit is closed from battery at the right back contact of relay 209 through the right winding of relay 210, back contact of rotary-stepping magnet 212, right winding of the slow-to-operate relay 213, commutator brush 214 and the marked segment 207 to ground at the outer front contact of group relay 200. Relay 213 is operated and relay 210 is held operated by the current in this circuit to prevent the advance of the brushes beyond the level in which conductors 131 to 136 of trunk CT terminate. Relay 213 locks in a circuit from battery at the right back contact of relay 209, through the winding of magnet 211, left winding and inner front contact of relay 213 to ground at the outer left front contact of relay 208. The magnet 211 is marginal and does not reoperate in series with the winding of relay 213.

In operating, relay 213 closes a circuit for operating the rotary-stepping magnet 212; this circuit is traced from battery through the winding of magnet 212, outer front contact of relay 213, contact of relay 210, over conductor 220 to ground at the front contact of relay 208. The operation of magnet 212 rotates the brushes into engagement with the first set of terminals in the level to which the brushes were advanced by magnet 211. The operation of magnet 212 opens the circuit through the right winding of relay 210 and if the conductors of trunk CT are not connected to the first set of terminals engaged by the brushes of finder TF, relay 210 releases. The release of relay 210 causes the release of magnet 212 and the release of magnet 212 recloses the circuit for operating relay 210. The interaction of relay 210 and magnet 212 continues, to advance the brushes of finder TF until test brush 206 encounters the terminal to which the winding of relay 111 is connected; at which time a

circuit is completed from battery through the winding of relay 111, left front contact of relay 110, left back contact of relay 115, conductor 136, test brush 206 of trunk finder TF, left winding of relay 210, outer left back contact of relay 209, left winding of relay 210, to ground at the inner left front contact of relay 208. Relay 111 is operated and relay 210 is held operated by the current in this circuit. Relay 210, by remaining energized, prevents further stepping of the switch. Relay 111 closes a locking circuit through its inner left front contact and causes the release of relay 110. Relay 210 is sufficiently energized by the current through its left winding to close its inner right front contact, the right winding of relay 210 being thereupon energized to cause the complete operation of this relay. The circuit for energizing the right winding of relay 210 is traced through its inner right front contact, the front contact of magnet 212, front contact of relay 210 over conductor 220 to ground at the front contact of relay 208. With relay 210 operated, a circuit is closed, for operating relay 209, from battery through the right winding of relay 209, outer left front contact of relay 210, to ground at the lower front contact of off-normal springs 215. Relay 209, in operating, extends start wire 218 over conductor 219 to the next finder in the group and causes the release of relays 208, 210, and 213, and the release of magnet 212. Before relay 208 releases, a holding circuit for relay 210 is closed from battery through its right winding and right front contact, middle left front contact of relay 209, brush 202 of trunk finder TF, conductor 132, outer right front contact of relay 111, outer right back contact of relay 115, conductor 122, back contact of relay 112, over sleeve conductor 121 to ground at the front contact of relay 107 of line finder LF; or, if relay 107 has released, due to the line finder LF having found and extended the calling line over the conductors of trunk CT to the line relay (not shown) of selector S1, holding ground potential is supplied over sleeve conductor 122 from a front contact of the release relay (not shown) of selector S1 in the usual and well known manner. Relay 252 is held operated, after relay 208 releases, over conductor 250, through brush 202 of trunk finder TF, by the holding ground potential connected to conductor 122. The ground potential connected to conductors 121 and 122 is also effective to operate and hold the cut-off relay 102 and to hold relay 111 operated after relay 110 releases. The holding circuit for relay 111 is traced from holding ground potential over conductor 122 through the outer right back contact of relay 115, the outer right front contact of relay 111, conductor 132, brush 202 of trunk finder TF, outer left front contact of relay 209, inner left front contact of relay 210, brush 206 of trunk finder TF, conductor 136, left back contact of relay 115 and through the inner left front contact and winding of relay 111 to battery. The release of relay 110 causes the release of group relay 200 if no other lines in the group with line 100 are awaiting extension to a zone determining train of switches.

With the calling line 100 extended through line finder LF over trunk CT to the first selector S1 of the completing train of switches and with selector S2 of the zone determining train connected through trunk finder TF to the charging trunk CT, further operation awaits the dialing of the called subscriber's number by the calling subscriber at station A, dialing tone being

transmitted over the calling line from selector S1 in the usual manner. The windings of relay 131 of trunk CT are in series with the conductors of line 100 during the dialing of the first four digits; so that relay 131 is operated in series with the line relay (not shown) of selector S1 awaiting the dialing of the first digit. The dialing of the first digit causes the operation of selector S1 to extend the connection over an idle trunk in a group corresponding to this digit to an outgoing repeater or a succeeding local selector. The desired connection is completed by the operation of the first and intermediate selectors and a connector C1 in response to the dialing of all of the digits of the called station's number in the usual manner, the holding ground potential connected to sleeve conductor 122 from the succeeding switches or from an outgoing repeater being under the control of the calling subscriber.

The alternate release and reoperation of relay 131 of trunk CT in response to the dialing of the first digit causes the alternate operation and release of relay 251 of selector S2 of the zone determining train of switches. The circuit for operating relay 251 is traced from ground at back contact of relay 131, inner lower back contact of relay 130, inner right front contact of relay 111, conductor 131, brush 201 of trunk finder TF, inner right back contact of relay 254, to battery through the winding of relay 251. Relay 251 operated, locks under control of the vertical-stepping magnet 256 and closes a circuit for energizing relay 253 and magnet 256 in series. Relay 253 is a slow-to-release relay and remains operated until all of the impulses in the train have been received by relay 251. The operation of the vertical-stepping magnet 256 opens the locking circuit for relay 251 and elevates the brushes 261 to 265 inclusive, to the first level of terminals in the bank of selector S2. The off-normal springs 257 are actuated when the shaft of selector S2 moves out of its normal position, thereby closing a circuit for operating relay 255, from battery through the winding of relay 255, upper contacts of springs 257, front contact of relay 253, conductor 250, through brush 202 of trunk finder TF to holding ground potential as hereinbefore traced. Relay 255 closes a locking circuit from battery through its winding, contacts of off-normal springs 257, back contact of the rotary-stepping magnet 258, inner front contact of relay 255, to ground at the outer right back contact of relay 254. The reoperation of relay 131 causes the release of relay 251, if magnet 256 has operated; and the release of relay 251 causes the release of magnet 256. The alternate operation and release of relay 251 under the control of relay 131 is, therefore, effective to cause the alternate operation and release of magnet 256. The operation of magnet 256 elevates the brushes of selector S2 step by step until the brushes reach the level corresponding to the first digit dialed. The release of relay 253, when all of the impulses have been received by relay 251, closes a circuit from battery through the winding of rotary-stepping magnet 258, outer front contact of relay 255, back contact of relay 253, over conductor 250 to holding ground potential as hereinbefore traced. The operation of magnet 258 opens the locking circuit for relay 255 and rotates the brushes of selector S2 into engagement with the first set of terminals in the selected level. The release of relay 255 opens the energizing circuit for magnet 258 and

the latter releases. If the first set of terminals is busy, the terminal engaged by test brush 262 will be connected to ground potential thereby causing the reoperation of relay 255 in a circuit traced from ground through brush 262, left back contact of relay 254, back contact of magnet 258, upper contacts of the off-normal springs 257 to battery through the winding of relay 255. Relay 255 again closes the circuit for operating magnet 258. The interaction between relay 255 and magnet 258 continues until the brushes of selector S2, advanced one step by each operation of relay 255, encounter the terminals of an idle trunk. Since the test terminal of an idle trunk is not connected to ground, relay 255 does not reoperate; but relay 254 is operated by the current in a circuit from battery through the winding of relay 255, upper contacts of off-normal springs 257, back contact of magnet 258, winding of relay 254, over conductor 250 to ground potential as hereinbefore traced. In operating, relay 254 prevents the further rotation of the brushes of selector S2 and connects ground potential over conductor 250 through its outer left front contact, through brush 262 to the test terminal of the selected trunk to guard against seizure of this trunk by any other hunting selector. This ground potential is further connected over conductor 302 to cause the operation of relay 308 of zone control unit Z3 and relay 412 of selector S4. Relay 254 also disconnects the back contact of impulse relay 131 of trunk CT from the winding of relay 251 of selector S2 and extends the connection from the back contact of relay 131 through the outer right front contact of relay 254 and brush 261 of selector S2, conductor 301, through the left back contact of relay 311 of zone control unit Z3, over conductor 401, through the left back contact of relay 414 and through the winding of relay 411 to battery.

The impulses generated by the dialing of the second digit, are effective to selectively operate the second switch in the completing train of switches and also to again cause the alternate release and reoperation of relay 131 of trunk CT. The selector S4 is similar to the selector S2 and its line relay 411 responds to the closing and opening of the back contact of relay 131 to control the operation of relay 413 and the vertical-stepping magnet 416. The brushes of selector S4 are thereby stepped up to the level of the terminal bank corresponding to the second digit dialed. The changeover relay 413 closes a circuit for operating the rotary-stepping relay 415 and, after completion of the vertical movement of the brushes, renders the rotary-stepping magnet 418 effective in cooperation with relay 415 to rotate the brushes until the terminals of an idle trunk are encountered. The operation of relay 414, when an idle set of terminals is reached, extends conductors 401, 402, 403, 404, and 405 through brushes 421, 422, 423, 424, and 425 over the conductors of the selected trunk to the associated connector C4. The ground potential connected to conductor 402 is thus extended through test brush 422 to the test terminal of the selected trunk to prevent seizure of this trunk by any other hunting selector.

The impulses generated by the dialing of the third and fourth digits of the number of the called station selectively operate the third and fourth switches of the completing train and also again cause the alternate release and reoperation of relay 131 of trunk CT. These impulses are repeated by the back contact of relay 131 to

direct the connector C4 to a terminal in its bank corresponding to the zone in which the called subscriber's line is located. The first release of relay 131 in response to the dialing of the third digit causes the operation of relay 451 of connector C4. Relay 451 locks under control of magnets 456 and 458 and closes a circuit for operating relay 453 and vertical-stepping magnet 456 in series. Relay 453 is a slow-to-release relay and remains operated until all of the impulses in the train have been received by relay 451. The operation of magnet 456 opens the locking circuit of relay 451 and elevates the brush 470 to the first level of the terminal bank. The actuation of the vertical off-normal springs 457 changes the operating circuit for relay 453 and magnet 456 to include the upper front contact of springs 457 and the front contact of relay 453 instead of the back contact of springs 457. With relay 131 reoperated and magnet 456 operated, relay 451 releases. The release of relay 451 causes the release of magnet 456. The operation and release of relay 451 and magnet 456 in response to each of the impulses of the third digit is, therefore, effective to elevate brush 470 to the level corresponding to the third digit dialed. Relay 453 releases after relay 451 has responded to the last impulse of the third digit. The operation of relay 451 in response to the first impulse of the fourth digit closes a circuit for operating relay 455 and the rotary-stepping magnet 458. This circuit is traced from ground through the right front contact of relay 451, upper front contact of vertical off-normal springs 457, back contact of relay 453, through the windings of relay 455 and magnet 458 to battery. Magnet 458 opens the locking circuit of relay 451 and rotates the brush of connector C4 to the first terminal in the selected level. Relay 455 is slow-to-release and remains operated until all of the impulses in the train have been received by relay 451. The rotary off-normal springs 460 are actuated when the brush of connector C is rotated, the operating circuit for relay 451 being thereafter traced through the front contact of relay 455 instead of through the lower contact of springs 459. The release of relay 451, when relay 131 reoperates, causes the release of magnet 458. Each alternate operation and release of relay 451 in response to the impulses created by the dialing of the fourth digit causes the operation and release of magnet 458, the brush 470 being rotated step-by-step into engagement with a terminal corresponding to the first four digits of the called subscriber's number and which is indicative of the zone in which the called line is located with respect to the calling line. The release of relay 455 after receipt of the last impulse of the train disconnects the winding of relay 451 from the back contact of relay 131 of trunk CT so that relay 451 is unaffected by the further release and reoperation of relay 131.

Since the system herein being described in detail is arranged for five zones, the terminals of connector C4 are each connected as required to represent a particular one of the five zones. Thus terminal 471 is one selected on a call to zone 1 and is not connected; terminal 472 is one selected on a call to zone 2 and is connected to the brush of interrupter drum 482; terminal 473 is one selected on a call to zone 3 and is connected to the brush of interrupter drum 483; terminal 474 is one selected on a call to zone 4 and is connected to the brush of interrupter drum 484; and terminal 475 is one selected on a call to zone

5 and is connected to the brush of interrupter drum 485.

Interrupter drums 479, 480, 482, 483, 484, and 485 which are common to a plurality of connectors, are mounted on one driving shaft, the time required for one cycle of rotation being 5 seconds. The interrupter is so arranged, that the initial closed periods through drums 479, 482, 483, 484, and 485 occur at the same time and so that the initial closed period through drum 480 occurs one second later. Interrupter drum 479 connects its brush to ground for an interval of .5 second followed by an open interval of 4.5 seconds; interrupter drum 480 connects its brush to ground (one second after the beginning of a cycle) for an interval of .5 second, followed by an open interval of .5 second and then by three alternate closed and open intervals of .5 second each; interrupter drum 482 connects its brush to ground for an interval of 1.5 seconds, followed by an open interval of 3.5 seconds; interrupter drum 483 connects its brush to ground for an interval of 2.5 seconds, followed by an open interval of 2.5 seconds; interrupter drum 484 connects its brush to ground for an interval of 3.5 seconds, followed by an open interval of 1.5 seconds; and interrupter drum 485 connects its brush to ground for an interval of 4.5 seconds, followed by an open interval of .5 second.

As soon after the release of relay 455 as the brush of pick-up interrupter 479 is connected to ground, a circuit is closed for operating relay 461; this circuit is traced from ground through interrupter drum 479, upper contact of the rotary off-normal springs 460, back contact of relay 455, outer right back contact of relay 462, through the left winding of relay 461 to battery. Relay 461 closes a circuit, for operating relay 462, from ground at the right front contact of relay 452, through the outer left front contact of relay 461, and through the inner back contact and winding of relay 462 to battery. Relay 462 locks through its inner right front contact to ground at the front contact of relay 452. Relay 462 also opens the operating circuit for relay 461. If the call is to zone 1, relay 461 releases immediately but if the call is to zone 2, 3, 4 or 5, relay 461 is held operated by a locking circuit from battery through its right winding and inner right front contact, through brush 470 of connector C4 to ground through that one of the interrupter drums 482 and 485 inclusive, to which the terminal engaged by brush 470 is connected. With relay 461 operated, a circuit is closed from ground at its outer right front contact, through the left front contact of relay 452, brush 423 of selector S4, inner left front contact of relay 414, conductor 403, winding of marginal relay 310 of zone-metering control unit Z3, conductor 303, brush 263 of selector S2, outer right front contact of relay 216, brush 203 of trunk finder TF, conductor 133, outer left front contact of relay 111, through the lower winding of relay 130, to battery. If the charging trunk is arranged for serving message-rate lines the lower winding of relay 130 is of low resistance and both relay 130 and marginal relay 310 are operated; but if the charging trunk is arranged for serving flat-rate lines, the lower winding of relay 130 is of sufficiently high resistance to prevent the operation of relay 310 and relay 130 alone is operated.

If relay 461 is held operated after relay 462 operates, the brush of interrupter drum 480 is connected through front contacts of these relays, through brush 425 of selector S4, outer right front

contact of relay 414, over conductor 405, to the winding of relay 318 of control unit Z3. On a call to zone 2, the interrupter drum 482 provides a locking ground for relay 461 for 1.5 seconds, and during this period interrupter drum 480 transmits one ground impulse to operate relay 318. On a call to zone 3 the interrupter drum 483 provides a locking ground for relay 461 for 2.5 seconds, and during this period interrupter drum 480 transmits two ground impulses to operate relay 318. On a call to zone 4, the interrupter drum 484 provides a locking ground for relay 461 for 3.5 seconds, and during this period interrupter drum 480 transmits three ground impulses to operate relay 318. On a call to zone 5, the interrupter drum 485 provides a locking ground for relay 461 for 4.5 seconds, and during this period interrupter drum 480 transmits four ground impulses to operate relay 318. The first operation of relay 318, under the control of interrupter drum 480, closes a circuit for operating relay 317; this circuit is traced from aforementioned holding ground potential connected to conductor 302, through the right front contact of relay 318, outer back contact of relay 324, outer back contact of relay 323, outer back contact of relay 322, back contact of relay 316 and through the winding of relay 317 to battery. Relay 317 locks through its outer right front contact to ground at the left front contact of relay 318 and at its innermost right front contact closes a circuit for operating relay 322. Relay 322 closes a locking circuit through its inner right front contact over conductor 312, to ground at the inner left front contact of relay 308. The release of relay 318, when its operating circuit is opened by interrupter drum 480, causes the release of relay 317. A second operation of relay 318, under control of interrupter drum 480, causes the operation of relay 316; the circuit for operating relay 316 is traced from battery through the winding of relay 316, back contact of relay 317, outer right front contact of relay 322, outer back contacts of relays 323 and 324, right front contact of relay 318, over conductor 302, to ground. Relay 316 locks through its outer left front contact to ground at the left front contact of relay 318 and at its innermost left front contact closes a circuit for operating relay 323. Relay 323 locks over conductor 312 to ground at the inner left front contact of relay 308. The release of relay 318, when its operating circuit is opened by interrupter drum 480, causes the release of relay 316. A third operation of relay 318 under control of interrupter drum 480 causes the operation of relays 317 and 324, the latter locking over conductor 312 to ground at relay 308. A fourth operation of relay 318 under control of interrupter drum 480 causes the operation of relays 316 and 325, the latter locking over conductor 312 to ground at relay 308. Thus on a call to zone 1 none of register relays 322, 323, 324 or 325 are operated; for a call to zone 2, relay 322 alone is operated; for a call to zone 3, relays 322 and 323 are operated; for a call to zone 4, relays 322, 323, and 324 are operated; and for a call to zone 5 all of the register relays 322, 323, 324, and 325 are operated.

The release of relay 461, due to the operation of relay 462 on a call to zone 1 or due to the opening of the holding circuit through its right winding when opened at that one of interrupter drums 482, 483, 484 or 485 to which it is connected on a call to one of zones 2, 3, 4 or 5, closes a circuit for operating relay 311 of control apparatus Z3; this circuit is traced from ground at the

right front contact of relay 452, left back contact of relay 461, inner left front contact of relay 462, brush 424 of selector S4, middle left front contact of relay 414, conductor 404 and through the winding of relay 311 to battery. Relay 311 locks through its right front contact to ground over conductor 302. The operation of relay 311 causes the release of relays 412, 414 and 452 and connects conductor 301 to the winding of relay 314. The release of relay 452 causes the release of relay 462 and the operation of release magnet 459 of connector C4. The release of relay 412 closes a circuit for operating release magnet 419 of selector S4. The operation of release magnets 459 and 419 cause the connector C4 and selector S4 to be restored to normal in the usual and well known manner. The connector C4, upon reaching normal, is free for use on another call.

The zone, in which the called line is located, having been registered in the zone-metering control apparatus Z3, this apparatus unit is now prepared to control the operation of the calling subscriber's meter in accordance with the duration and destination of the call.

It will be assumed, first that the calling line is a message-rate subscriber's line and that relays 130 and 310 have both been operated as hereinbefore described. Relay 130 closes a locking circuit through its upper winding to ground over the sleeve conductor 122, and connects the windings of polarized relay 132 in series with the conductors of the calling line in place of the windings of relay 131. In response to the dialing of the remaining digits of the called subscriber's number, the connection is extended to the calling line, the connector C1 being the last switch in the completing train. The calling station is signaled in the usual manner and when the called subscriber answers, the current is reversed over the talking conductors of trunk CT in the usual manner, thereby operating the polarized supervisory relay 132. In operating, relay 132 closes a circuit for operating relay 314; this circuit is traced from ground at the front contact of relay 132, through the inner lower front contact of relay 130, inner right front contact of relay 111, conductor 131, brush 201 of trunk finder TF, outer right front contact of relay 254, brush 261 of selector S2, conductor 301, outer left front contact of relay 311, through the winding of relay 314 to battery. With relay 314 operated, the right winding of relay 306 is connected through the outer right back contact of relay 307, front contact of relay 314, left back contact of relay 307, and the left back contact of relay 306 to the brush of interrupter drum 342.

The interrupter drums 340, 341, 342, and 343 are common to a plurality of zone-metering control units such as Z3. Interrupter drums 342 and 343 each have a 3-second cycle of rotation, comprising a .5 second closure and 2.5 second open period; but the closure through drum 342 precedes the closure through drum 343 by two seconds. As soon after relay 314 operates as interrupter drum 342 connects ground to its brush, relay 306 is operated by the energization of its right winding. Relay 306 locks through its left front contact, over conductor 312, to ground at the front contact of relay 308. At its right front contacts relay 306 connects its left winding in parallel with the winding of relay 307 to the brush of interrupter 343. When the brush of drum 343 is connected to ground, from 2 to 2.5 seconds after relay 306 operates, relay 306 is held

operated by its left winding, and relay 307 is operated. Relay 307 locks in an obvious circuit, connects the brush of interrupter drum 340, through the outer right front contact of relay 307, front contact of relay 314, middle left front contact of relay 307, terminal 1 (normal terminal) and brush of bank 334 of timing switch K, outer left front contact of relay 308, brush and terminal 1 of bank 333, inner left front contact of relay 307, inner right front contact of relay 308, to the winding of stepping relay 319. Relay 306 releases as soon as its holding circuit is opened at interrupter drum 343. The delay between the operation of relay 314 and the operation of relay 307 is introduced to prevent the advance of switch K out of normal, and the closing of the meter operating circuit, in case the polarized relay 132 should be operated momentarily due to a trunk or line busy signal. With relay 307 operated, ground is connected through the brush and terminals 1 to 10 inclusive of bank 335 of switch K to conductor 302 to prevent the release of the line finder LF, in case the calling subscriber releases the connection, until the meter of the calling subscriber has been operated under control of switch K the proper number of times as a charge for the call. Interrupter drum 340 connects its brush to ground once every second for approximately .5 second and interrupter drum 341 connects its brush to ground once every 30 seconds for approximately .5 second. As soon after relay 307 operates as the brush of drum 340 is connected to ground, stepping relay 319 is operated to initiate the advance of timing switch K. Relay 319 closes an obvious circuit for operating stepping magnet 330. At the end of the .5 second closure through interrupter drum 340, relay 319 and magnet 330 are released. The release of magnet 330 advances the brushes of switch K from position 1, the normal position, to position 2 in which a circuit is closed through the brush and terminal 2 of bank 332 for operating relay 313. Relay 313 closes a circuit from ground through its contacts, over conductor 304, through brush 264 of selector S2, inner right front contact of relay 254, middle right front contact of relay 216, brush 204 of trunk finder TF, over conductor 134, and through the winding of relay 112 of trunk CT to battery. Relay 112 is operated by the current in this circuit, thereby causing the operation of relay 114 and the operation of the calling subscriber's meter 104; the circuit for operating meter 104 is traced from the negative pole of battery, through its winding, a front contact of relay 114, front contact of cut-off relay 102, conductor 103, sleeve brush of line finder LF, front contact of relay 108, sleeve conductor 121, and through the left front contact of relay 112 to the positive pole of booster battery 113. In position 2 of switch K, the winding of stepping magnet 330 is connected through its own back contact, over conductor 320, through terminal 2 and brush of bank 333, outer left front contact of relay 308, brush and terminal 2 of bank 334 to the brush of interrupter drum 340; and as soon as this brush is again connected to ground, magnet 330 operates, opens its operating circuit, and releases to advance the brushes to position 3. The advance of the brushes out of position 2 causes the release of relays 313, 112 and 114 and the release of meter 104.

If the call is a local call, (that is, the called line is in zone 1 with respect to the calling line),

none of the zone register relays 322, 323, 324, and 325 were operated and the aforementioned operation of meter 104 completes the charge for the call; and since no additional charge is made for overtime periods, the timing switch K may be advanced to normal without measuring off a unit period of time. To this end a circuit is closed from battery through the winding and back contact of magnet 330, through the brush and terminal 3 of bank 331, left front contact of relay 310, winding of relay 309, inner left front contact of relay 311, left back contact of relay 322, over conductor 312 to ground at the inner left front contact of relay 308. Relay 309 is operated by the current in this circuit but magnet 330 is marginal and does not operate. The operation of relay 309 closes a circuit for operating relay 115 of trunk CT; this circuit is traced from battery through the winding and continuity back contact of relay 115, over conductor 135, through brush 295 of trunk finder TF, middle left front contact of relay 216, inner left front contact of relay 254, brush 265 of selector S2, conductor 305, front contact of relay 309, over conductor 302 to ground as hereinbefore traced. Relay 115 locks over conductor 122, causes the release of relay 111, and disconnects conductor 122 from conductor 132. The release of relay 111 causes the immediate release of relays 310 and 314 but relays 216, 252, 254, 308, and 311 are held operated through the brush of bank 335 until the brushes of switch K are advanced beyond position 10.

In any case, whether a local call or a call to one of zones 2, 3, 4, and 5, the stepping relay 319 is reoperated as soon as the brushes enter position 3; this circuit is traced from its winding through the inner right front contact of relay 308, terminal 3 and brush of bank 333, outer left front contact of relay 308, brush and terminal 3 of bank 334 to the brush of interrupter drum 340. Relay 319 closes the circuit for reoperating magnet 330 and as soon as ground is disconnected from the brush of drum 340, relay 319 and magnet 330 release, thereby stepping the brushes of switch K to position 4. The advance of switch K from each of positions 4, 6, 8, and 10 to each of positions 5, 7, 9; and 11 and the advance of switch K from each of positions 5, 7, and 9 to each of positions 6, 8, and 10 is effected in the manner in which the advance is effected from position 2 to position 3 and from position 3 to position 4 as hereinbefore described.

If the called line is in zone 1, relays 216, 252, 254, 308, and 311 release when the brush of bank 335 advances beyond terminal 10. The release of relay 216 closes a circuit for operating release magnet 230 of trunk finder TF; this circuit is traced from the winding of magnet 230, through the upper front contact of off-normal springs 215, right back contact of relay 213, left back contact of relay 216, back contact of relay 208, to ground at the lower front contact of off-normal springs 215. The operation of magnet 230 restores switch TF to normal and relay 208 releases when springs 215 return to normal position unless a call is then waiting, in which case relay 208 is held operated until the group relay 200 releases. The aforementioned release of relay 252 of selector S2 closes a circuit for operating release magnet 259 to restore this switch to normal. The release of relay 308 causes the release of all relays holding over conductor 312 and closes a circuit from battery through the winding and interrupter contacts of magnet 330, over

conductor 320, through the inner right back contact of relay 308, terminals 11 to 21 inclusive and brush of bank 333 to ground at the left back contact of relay 308. The magnet 330 is thereby alternately operated and released to advance the switch to position 22. In position 22 a circuit is closed for operating relay 315; this circuit is traced from battery through the winding and continuity back contact of relay 315, terminal 22 and brush of bank 333, to ground at the left back contact of relay 308. Relay 315 locks through its right front contact, the outer right back contact of relay 308, and through terminal 22 and brush of bank 335. Relay 315 closes a circuit through terminal 22 and brush of bank 331 and the interrupter contacts of magnet 330 for operating magnet 330. The release of magnet 330, due to its operation, advances the timing switch K to normal position.

If the call is to one of zones 2, 3, 4 or 5, relay 313 is reoperated one or more times as controlled by zone register relays 322, 323, 324, and 325 during the advance of switch K to position 11. Thus, on a call to zone 2, 3, 4 or 5, relay 322 has been operated and relay 313 is operated a second time while the brushes of switch K are in position 4; on a call to zone 3, 4 or 5, relays 322 and 323 have been operated and relay 313 is operated a third time while the brushes of switch K are in position 6; on a call to zone 4 or 5, relays 322, 323, and 324 have been operated and relay 313 is operated a fourth time while the brushes of switch K are in position 8; and on a call to zone 5, relays 322, 323, 324, and 325 have been operated and relay 313 is operated a fifth time while the brushes of switch K are in position 10. Each additional operation of relay 313 causes a corresponding operation of relay 112 of trunk CT and meter 104 in the manner hereinbefore described; so that meter 104 is operated twice on a call to zone 2, thrice on a call to zone 3, four times on a call to zone 4 and five times on a call to zone 5. When the brushes of switch K enter position 11 and in each of positions 11 to 21 inclusive, the winding of stepping relay 319 is connected through the inner right front contact of relay 308, brush of bank 333, outer left front contact of relay 308, and through the brush of bank 334 to the brush of interrupter drum 341. Since this interrupter drum connects ground to its brush once every 30 seconds, the brushes of switch K are now advanced by the operation of relay 319 and magnet 330 one step every 30 seconds into position 22, at which time a 5-minute interval has been measured as an initial unit period for which the meter was operated two or more times according to the zone in which the called line is located. As soon as the brushes of switch K enter position 22, a circuit is closed for operating relay 315; this circuit is traced from battery through its winding and back contact, terminal 22 and brush of bank 333, outer left front contact of relay 308, and through the brush and terminal 22 of bank 334 to ground. Relay 315 locks through its right front contact to ground at the outer right front contact of relay 308 and closes the circuit which includes terminal 22 and brush of bank 331 for operating magnet 330. The operation and release of magnet 330 advances the brushes of switch K to normal.

If conversation has not been completed by the end of the initial period of five minutes, as indicated by the continued operation of the polarized supervisory relay 132, the described cycle of ad-

vance of switch K, for operating the meter 104 and for measuring off a 5-minute period, is repeated. On the initial revolution, the advance of switch K from position 21 to position 22 is controlled by interrupter drum 341 to insure that the first period will not be reduced to less than five minutes by an immediate operation of relay 319 as soon as the brushes reach position 11. But on succeeding cycles, the switch is advanced immediately from terminal 21 to terminal 22 the circuit for operating magnet 330 being closed by relay 315 in both of positions 21 and 22.

When the connection is released at the called station, the release of polarized supervisory relay 132 causes the release of relay 314 if the called station is in zone 2, 3, 4 or 5. When the connection is released at the calling station, holding ground potential is disconnected from conductor 122 and the switches of the completing train are restored to normal in usual manner. On a call to zone 1, the disconnection of the holding ground potential at the outgoing repeater or connector C1 from the sleeve conductor 122 of trunk CT also causes the release of the cut-off relay 102 and relay 115 of trunk CT and the return of the line finder LF to normal, the zone determining train and control unit having already been restored to normal as hereinbefore described. But, on a call beyond zone 1, the cut-off relay 102, relays 109 and 111 of trunk CT, relay 216 of trunk finder TF, relays 252 and 254 of selector S2, and relays 308 and 311 of control unit Z3 are held operated if timing switch K is in any one of positions 1 to 10 inclusive, until the brushes of this switch advance beyond position 10, at which time the release of these relays causes the return of switches LF, TF and S2 to normal and the advance of switch K to normal as hereinbefore described.

If the calling subscriber is a flat-rate subscriber the meter 104 is to be operated only on calls outside of zone 1 and to secure this result the lower winding of relay 130 is of sufficient resistance to prevent the operation of marginal relay 310 of control unit Z3 when the windings of these relays are connected in a series circuit as hereinbefore described. When relay 311 of control unit Z3 operates, and if the called line is in zone 1 as indicated by the fact that register relay 322 has not been operated, a circuit is closed for operating relay 309; this circuit is traced from battery through the winding and interrupter contacts of magnet 330 of switch K, through the brush and terminal 1 of bank 331, back contact of relay 310, winding of relay 309, inner left front contact of relay 311, left back contact of relay 322, over conductor 312 to ground at the front contact of relay 308. The operation of relay 309 causes the operation of relay 115 of trunk CT. The operation of relay 115 prevents the operation of relay 314 of control unit Z3 when the called subscriber answers and causes the immediate release of relays 308 and 311 of control unit Z3 thereby preventing the advance of timing switch K out of normal position. The operation of relay 115 also causes the release of relay 111 of trunk CT, the release of relay 216 of trunk finder TF, and the release of relays 252 and 254 of selector S2. The trunk finder TF and selector S2 are thereupon restored to normal as hereinbefore described. On calls to zones 2, 3, 4, and 5, relay 309 cannot operate since zone register relay 322 is operated; and on these calls the timing switch K is advanced and the

calling subscriber's meter operated as hereinbefore described.

Referring now to the alternative arrangement comprising Figs. 1, 2, and 5 arranged as shown in Fig. 7, the calling line 100 is extended to the trunk CT and selector S1 and through the trunk finder TF to the auxiliary selector S2 in the manner hereinbefore described. The dialing of the first digit of the number of the subscriber's station with which connection is desired causes the selective response of the selector S1 of the completing train of switches and the selective response of selector S2 of the zone determining train of switches. The dialing of the second digit causes the selective response of the second switch (not shown) in the completing train and the selective response of a second switch S5 of the auxiliary zone determining train. Assuming that two digits only are required to determine the zone within which the called line is located with respect to the calling line and that the zone-metering control unit Z5 is the one selected by switches S2 and S5 in response to these two digits, the holding ground potential is extended from sleeve conductor 122 of trunk CT, through the outer right back contact of relay 115, outer right front contact of relay 111, over conductor 132, through brush 202 of trunk finder TF, outer left front contact of relay 254 of selector S2, brush 262 of selector S2, brush 502 of selector S5, conductor 522, to the winding of relay 508 of zone-metering control unit Z5. Relay 508 operates thereby connecting ground to conductor 512. The seizure of control unit Z5 also closes a circuit from battery through the lower winding of relay 130 of trunk CT, outer left front contact of relay 111, conductor 133, brush 203 of trunk finder TF, outer right front contact of relay 216, brush 263 of selector S2, brush 503 of selector S5, and through the winding of relay 510 of control unit Z5 to ground. Relay 130 is operated by the current in this circuit and if the trunk CT is associated with message-rate lines the resistance of the lower winding of relay 130 is of low enough resistance to cause the operation of marginal relay 510; but if the trunk CT is associated with flat-rate lines, the resistance of the lower winding of relay 130 is high enough to prevent the operation of relay 510. Relay 130 closes a locking circuit through its upper winding to ground over sleeve conductor 122 and connects the windings of polarized relay 132 in series with the calling line in place of the windings of relay 131. When dialing has been completed and the called subscriber answers, the current is reversed in well known manner to cause the operation of the polarized supervisory relay 132. Relay 132 closes a circuit for operating relay 514 of zone-metering control unit Z5; this circuit is traced from ground through the front contact of relay 132, inner lower front contact of relay 130, inner right front contact of relay 111, conductor 131, brush 201 of trunk finder TF, outer right front contact of relay 254, brush 261 of selector S2, brush 501 of selector S5, conductor 521, and through the winding of relay 514 to battery. With relay 514 operated, the right winding of relay 506 is connected through the outer left back contact of relay 507, contacts of relay 514, right back contact of relay 507, and the back contact of relay 506 to the brush of interrupter drum 542. The interrupter drums 542 and 543 each have a 3-second cycle of rotation comprising a .5-second closure and a 2.5-second open period; but the closure

through drum 542 precedes the closure through drum 543 by two seconds. As soon after relay 514 operates as interrupter drum 542 connects ground to its brush, relay 506 is operated by the energization of its right winding. Relay 506 locks through its left front contact, over conductor 512 to ground at the front contact of relay 508; and at its right front contacts, relay 506 connects its left winding in parallel with the winding of relay 507 to the brush of interrupter drum 543. When the brush of drum 543 is connected to ground, from 2 to 2.5 seconds after relay 506 operates, relay 506 is held operated by its left winding and relay 507 is operated. Relay 507 locks under control of relay 508, connects the brush of interrupter drum 540, through the middle left front contact of relay 507, front contact of relay 514, outer right front contact of relay 507, terminal 1 (normal terminal) and brush of bank 534 of timing switch M, inner right front contact of relay 508, brush and terminal 1 of bank 533 of switch M, inner right front contact of relay 507, outer left front contact of relay 508, to the winding of stepping relay 519. Relay 506 releases as soon as its holding circuit is opened at interrupter drum 543. The delay between the operation of relay 514 and the operation of relay 507 is introduced to prevent the advance of switch M out of normal position and the closing of the meter operating circuit in case the polarized relay 132 should be momentarily operated due to a trunk or line busy signal. With relay 507 operated, ground is connected through the brush and terminals 1 to 10 inclusive, of bank 535 of switch M to conductor 522 to prevent the release of the line finder LF, in case the calling subscriber releases the connection, until the meter of the calling subscriber has been operated under control of switch M the proper number of times as a charge for the call. Interrupter drum 540 connects its brush to ground once every second for approximately .5 second and interrupter drum 541 connects its brush to ground once every 30 seconds for approximately .5 second. As soon after relay 507 operates as the brush of drum 540 is connected to ground, stepping relay 519 operates to initiate the advance of timing switch M. Relay 519 closes an obvious circuit for operating stepping magnet 530 and, at the end of the .5-second closure through interrupter drum 540, relay 519 and magnet 530 are released. The release of magnet 530 advances the brushes of switch M from position 1, the normal position, to position 2 in which a circuit is closed through the brush and terminal 2 of bank 532 for operating relay 513. Relay 513 closes a circuit from ground through its front contact over conductor 524, through brush 504 of selector S5, brush 264 of selector S2 thence to and through the winding of relay 112 of trunk CT to cause the operation of meter 104 as hereinbefore described. In position 2 the winding of stepping magnet 530 is connected through its own back contact, over conductor 520, through terminal 2 and brush of bank 533, inner right front contact of relay 508, brush and terminal 2 of bank 534, to the brush of interrupter drum 540; and as soon as this interrupter brush is again connected to ground, magnet 530 operates, opens its operating circuit, and releases to advance the brushes of switch M to position 3. Relay 513 releases when the brushes advance out of position 2 to cause the release of relay 112 of trunk CT and the release of the meter 104. The bank 532 of switch M is wired as required

for controlling the charge on calls to zone 5, each of terminals 2, 4, 6, 8 and 10 being connected to ground. If control unit Z5 was one selected for use on calls to zone 1, only terminal 2 would be connected to ground; if control unit Z5 was one selected for use on calls to zone 2, only terminals 2 and 4 would be connected to ground; if control unit Z5 was one selected for use on calls to zone 3, only terminals 2, 4, and 6 would be connected to ground; and, if control unit Z5 was one selected for use on calls to zone 4, only terminals 2, 4, 6, and 8 would be connected to ground.

If the called line is in zone 1, that is, in the same zone as the calling line, the single operation of meter 104 completes the charge for the call; and since no additional charge is made for over-time periods, the timing switch M may be advanced to normal without measuring off a unit period of time. To this end, the zone control unit Z5, if arranged for use on zone 1, calls, would be further modified by connecting the front contact of relay 510 to terminal 3 of bank 531 and the back contact of relay 510 to terminal 1 of bank 531. If thus modified, a circuit is closed (on calls from message-rate lines), when the brushes of switch M enter position 3 for operating relay 509; this circuit is traced from battery through the winding and interrupter contacts of magnet 530, conductor 520, brush and terminal 3 of bank 531, front contact of relay 510, winding of relay 509, to ground at the inner left front contact of relay 508. Magnet 530 is marginal and does not operate in series with the winding of relay 509. Relay 509 closes a circuit from ground through its front contact over conductor 525, through brush 505 of selector S5 and brush 265 of selector S2, thence to and through the winding of relay 115 of trunk CT as hereinbefore described to cause the immediate release of relays 111, 510, and 514. Relays 216, 252, 254, and 508 are held operated through the brush of bank 535 until the brushes of switch M are advanced beyond position 10.

In any case, whether Z5 is arranged for a local call or for a call to one of zones 2, 3, 4, and 5, the stepping relay 519 is reoperated as soon as the brushes enter position 3; this circuit is traced from its winding through the outer left front contact of relay 508, terminal 3 and brush of bank 533, inner right front contact of relay 508, brush and terminal 3 of bank 534, and through drum 540 to ground. Relay 519 closes the circuit for reoperating magnet 530 and as soon as the closure through drum 540 is ended, relay 519 and magnet 530 release, thereby stepping the brushes of switch M to position 4. The switch M is advanced from each of positions 4, 6, 8, and 10 to each of positions 5, 7, 9, and 11 and from each of positions 5, 7, and 9 to each of positions 6, 8 and 10 in the manner in which it is advanced from position 2 to position 3 and from position 3 to position 4 as hereinbefore described.

If the called line is in zone 1 and control unit Z5 is arranged for zone 1 metering control, relays 216, 252, 254, and 508 release when the brush of bank 535 advances beyond terminal 10 and the trunk finder switch TF and selector S2 are restored to normal, as hereinbefore described. The selector S5 is also restored to normal in similar manner to that in which the selector S2 is restored to normal. The release of relay 508 of control unit Z5 causes the release of relay 507 and the immediate advance of timing switch M from position 11 to position 22, the circuit for operating magnet 530 being traced from battery

through its winding and interrupter contacts, conductor 520, left back contact of relay 508, terminals 11 to 21 inclusive and brush of bank 533, to ground at the inner right back contact of relay 508. When the brushes enter position 22, a circuit is closed for operating relay 515; this circuit is traced from battery through the winding and back contact of the continuity spring of relay 515, terminal 22 and brush of bank 533, to ground at the inner right back contact of relay 508. Relay 515 locks through the front contact of its continuity springs and the outer right back contact of relay 508 to ground at terminal 22 of bank 535. Relay 515 connects ground to terminals 21 and 22 of bank 531 to cause the operation of magnet 530. The release of magnet 530 due to the opening of its interrupter contacts, advances the brushes of switch M to normal.

If the zone control unit Z5 is arranged for zone 2, 3, 4 or 5, relay 513 is reoperated one or more times while the timing switch M is being advanced from position 3 to position 11. Thus a zone-metering control unit for use on calls to zone 2 will be arranged to operate relay 513 twice, while the timing switch is being advanced to position 11, to cause two operations of meter 104; a control unit for use on calls to zone 3 will be arranged to operate relay 513 three times to cause three operations of meter 104; a control unit for use on calls to zone 4 will be arranged to operate relay 513 four times to cause four operations of meter 104; and a control unit for use on calls to zone 5 will be arranged to operate relay 513 five times to cause five operations of meter 104. When the brushes of switch M, of any control unit used on calls to zone 2, 3, 4, or 5, enter position 11 and in each of positions 11 to 21 inclusive, the winding of stepping relay 519 is connected through the outer left front contact of relay 508, terminals 11 to 21 inclusive and brush of bank 533, inner right front contact of relay 508, brush and terminals 11 to 21 inclusive of bank 534, to the brush of interrupter drum 541. Since this drum connects ground to its brush once every 30 seconds, the brushes of switch M are advanced by the operation of relay 519 and magnet 530 one step every 30 seconds into position 22, at which time a 5-minute interval has been measured as an initial unit period for which the meter was operated two or more times according to the wiring of the bank 532. When the brushes of switch M enter position 22, a circuit is closed for operating relay 515; this circuit is traced from battery through the winding and back contact of the continuity spring of relay 515, terminal 22 and brush of bank 533, inner right front contact of relay 508, through the brush and terminal 22 of bank 534 to ground. Relay 515 locks through its continuity front contact to ground at the outer right front contact of relay 508, and closes the circuit for operating magnet 530 as hereinbefore described to advance the brushes of switch M to normal.

If conversation has not been completed by or before the end of the initial period of five minutes, as indicated by the continued operation of the polarized supervisory relay 132, the described cycle of advance of switch M for operating the meter 104 and for measuring off a 5-minute period is repeated. On succeeding cycles the switch M is advanced immediately from position 21 to position 22 without waiting for the closing of interrupter 541, relay 515 having been locked operated under control of relay 508.

When the connection is released at the called

station, the release of relay 132 causes the release of relay 514 if the called line is in zone 2, 3, 4 or 5. When the connection is released at the calling station, holding ground potential is disconnected from conductor 122 and the switches of the completing train are restored to normal in usual manner. On a call to zone 1 the disconnection of holding ground potential from conductor 122 of trunk CT also causes the release of the cut-off relay 102 and relay 115 of trunk CT and return of line finder LF to normal, the zone determining train and control unit having already been restored to normal as hereinbefore described. But, on a call beyond zone 1, the cut-off relay 102, relays 130 and 111 of trunk CT, relay 216 of trunk finder TF, relays 252 and 254 of selector S2, the holding relay (not shown) of selector S5 and relay 508 of control unit Z5 are held operated if the timing switch is in any of positions 1 to 10 inclusive, until this switch is advanced beyond position 10 at which time the release of these relays causes the return of switches LF, TF, S2 and S5 to normal and the advance of timing switch M to normal.

If the calling subscriber is a flat-rate subscriber the motor 104 is to be operated only on calls outside of zone 1 and to secure this result the lower winding of relay 130 is of sufficient resistance to prevent the operation of marginal relay 510 of control unit Z5 when the windings of these relays are connected in a series circuit as hereinbefore described. With terminal 1 of bank 531 connected to the back contact of relay 510, relay 509 operates as soon as relay 508 is operated, the operating circuit being traced from battery through the winding and interrupter contact of magnet 530, conductor 520, brush and terminal 1 of bank 531, back contact of relay 510, winding of relay 509, to ground at the inner left front contact of relay 508. The operation of relay 509 causes the operation of relay 115 of trunk CT and the release of relay 111, thereby preventing the operation of polarized supervisory relay 132 from being effective to operate relay 514 of control unit Z5. The trunk finder TF, selector S2 and selector S5 are immediately restored to normal without meter 104 having been operated. If, however, a call is made from a flat-rate station to a called line in zone 2, 3, 4, or 5, relay 509 of the selected zone-metering control unit cannot be operated in either of position 1 or 3 since the conductors connecting terminals 1 and 3 of bank 531 to the contacts of relay 510 are lacking. On such calls the calling subscriber's meter is operated and the call is timed by the operation of switch M as hereinbefore described.

What is claimed is:

1. In a multi-zone telephone system, subscribers' lines, means including selector switches for establishing a talking connection between a calling one of said lines and a called line, an impulse dial for said calling line for use in controlling said switches, a meter for registering charges for calls originating over said calling line, means for operating said meter, means for automatically determining the charge to be made for a call in accordance with the zone within which the called line is located and for controlling said meter operating means, a finder switch for automatically associating said charge determining means with said calling line, and means operative in response to the initiation of the call without dialing for starting said finder switch.

2. In a multi-zone telephone system, subscribers' lines, means including impulse responsive se-

lector switches for establishing a talking connection between a calling one of said lines and a called line, an impulse dial for said calling line for use in controlling said switches, a meter for registering charges for calls originating over said calling line, auxiliary selector switches for response to trains of impulses created by the dialing of as many digits of the number of the called line as are required to determine the zone within which the called line is located, means responsive to the initiation of the call over said calling line for associating the first of said auxiliary switches with said calling line, and means including a timing switch individual to one of said auxiliary switches for controlling the operation of said meter in accordance with the zone within which the called line is located.

3. In a multi-zone telephone system, a calling subscriber's line and station, an impulse dial at said station, a called subscriber's line and station, a train of selector switches used in completing a talking connection between said stations, each of said switches being selectively responsive to current impulses created by the dialing of a different one of the digits of the number of the called station, an auxiliary train of selector switches used in determining the zone within which the called station is located, each of said auxiliary switches being selectively responsive to a different one of the digits of the number of the called station, means including a finder switch and responsive to the initiation of the call for associating said calling station with the first selector switch in each of said trains.

4. In a telephone system, a first subscriber's station including an impulse dial, a second subscriber's station, a first selector switch, means responsive to the origination of a call at said first station for connecting said station to said first selector switch, a train of selector switches including said first selector switch for use in completing a talking connection between said stations, each of said switches being selectively responsive to current impulses created by the dialing of a different one of the digits of the number of said second station, an auxiliary train of selector switches each responsive to a different one of the digits of the number of said second station, and means including a finder switch operatively responsive to the initiation of the call for associating the first switch of said auxiliary train with said calling station.

5. In a multi-zone telephone system, a calling subscriber's line and station, an impulse dial at said station, a called subscriber's line and station, a train of selector switches for establishing a talking connection between said calling and called stations, another train of selector switches for use in determining the zone within which the called line is located, each of the switches of both trains being operatively controlled by impulses created by the operation of said dial, finder switches, one for the first selector of each of said trains, and means including said finder switches and responsive to the initiation of a call for associating said calling line with the first selector of each of said trains.

6. In a multi-zone telephone system, subscribers' lines and stations, selector switches for use in completing talking connections between calling and called lines, switching means for connecting a calling one of said lines to an idle one of said selector switches, an impulse dial at each calling station, an impulse relay individual to and adapted to control the selective operation of each of

said selectors, auxiliary switches for use in determining the zone within which the called station is located, switching means responsive to the initiation of a call for associating an idle one of said auxiliary switches with an interconnected calling line and selector switch, and an auxiliary impulse relay individual to each of said selector switches for use in controlling the selective operation of an associated one of said auxiliary switches.

7. In a telephone system, subscribers' stations and lines in each of a plurality of zones, a calling station, a called station, an impulse dial at said calling station for use in controlling the establishment of a connection with said called station, a meter for said calling station, switching means including a first selector switch for use in establishing connections between the calling and called stations, a line finder switch, a trunk permanently connecting said line finder and first selector switches, meter operating means for said trunk, means responsive to the initiation of a call at said calling station for operating said line finder switch to establish connection with a calling line, zone metering control units each adapted to control said meter operating means for calls to a different one of the zones, auxiliary selector switches for use in selecting a zone metering control unit, means responsive to the initiation of a call at said calling station for associating an idle one of said auxiliary selector switches with the calling line, means in said trunk for repeating to the associated auxiliary selector switch the impulses for as many digits as are necessary to complete the selection of a zone metering control unit in accordance with the zone in which the called station is located, and means in the selected control unit set in operation upon answer of the called subscriber for causing the operation of said meter operating means the required number of times.

8. In a telephone system, subscribers' stations and lines in each of a plurality of zones, a calling station, a called station, an impulse dial at said calling station, a meter for said calling station, a line finder switch, a first selector, a trunk connecting said line finder and first selector switches, a train of selector switches including said first selector switch each controlled by a train of impulses from said dial for completing the connection between the calling and called lines, meter operating means associated with said trunk, auxiliary selector switches of a plurality of orders for use in determining the zone within which a called line is associated, zone metering control units associated with the switches of one of said orders and adapted to control said meter operating means as required for each of a plurality of zones, means responsive to the initiation of a call over said calling line for associating an idle auxiliary selector switch of the first order with said calling line, means for controlling the operation of said associated auxiliary selector switch of the first order and any selected auxiliary switches of succeeding orders in response to as many digits of the called subscriber's number as are necessary to determine the zone within which the called line is located, means individual to the terminal selected by the last switch of the zone determining train for indicating the zone thus determined to the zone metering control unit associated with one of the auxiliary switches of the zone determining train, and means in said control unit effective upon answer of the called subscriber for operating said meter operating means a varying

number of times depending upon the indicated zone.

9. In a telephone system according to claim 7, timing means associated with said zone metering control unit for measuring off unit periods of time while a talking connection is maintained between the calling and called stations, the operation of said meter operating means at the beginning of the initial unit period being repeated at the beginning of each succeeding period.

10. In a telephone system according to claim 8, timing means associated with said control unit for measuring off unit periods of time while a talking connection is maintained between the calling and called stations, the operation of said meter operating means at the beginning of said initial period being repeated at the beginning of each overtime period.

11. In a multi-zone telephone system, subscribers' lines, means including impulse responsive selector switches for establishing a talking connection between a calling one of said lines and a called line, an impulse dial for said calling line for use in controlling said switches, a meter for registering charges for calls originating over said calling line, auxiliary selector switches for response to trains of impulses created by the dialing of as many digits of the number of the called line as are required to determine the zone within which the called line is located, means responsive to the initiation of the call over said calling line for associating the first of said auxiliary switches with said calling line, and means including a timing switch individual to one of said auxiliary switches for controlling the operation of said meter in accordance with the zone within which the called line is located and in accordance with the duration of the talking connection.

12. In a multi-office telephone system, subscribers' lines and stations, a calling station, an impulse dial at said calling station for use in establishing a connection with any other station, a meter for said calling station, switching means including a first selector switch operatively responsive to dial impulses for use in completing a talking connection between said calling station and a called station, metering control units comprising a timing switch for use in controlling the operation of said meter on calls of different values, each of said units being arranged for use on calls of only one value, auxiliary selector switches responsive to dial impulses for use in selecting a metering control unit corresponding to the value of the call being established, and switching means responsive to the initiation of a call for connecting the calling line with said first selector and for operatively associating the calling line with one of said auxiliary selector switches.

13. In a multi-office telephone system, subscribers' lines and stations, a calling station, an impulse dial at said calling station for use in establishing a connection with any other station, a meter for said calling station, switching means including a first selector switch operatively responsive to dial impulses for use in completing a talking connection between said calling station and a called station, auxiliary selector switches operatively responsive to dial impulses for use in determining the charge for a call originated at said calling station, a meter control unit comprising a timing switch for use in assessing varying charges, switching means responsive to the initiation of a call over said calling line for connecting said calling line with said first selector

and for operatively associating said calling line with one of said auxiliary selector switches, and means selected by said auxiliary switches for setting said meter control unit for charging at the required rate for any particular call.

14. In a telephone system, according to claim 7, means effective immediately after operation of said meter operating means on a local call for causing the release of said auxiliary selector switch.

15. In a telephone system, according to claim 8, means effective immediately upon operation of said meter operating means on a local call for causing the release of said control unit.

16. In a telephone system, according to claim 2, means effective immediately upon determination of the zone within which the called line is

located for causing the release of the auxiliary selector switches succeeding the one with which said timing switch is associated.

17. In a telephone system, according to claim 8, means effective immediately upon determination of the zone within which the called line is located for causing the release of the auxiliary selector switches succeeding the one with which said control unit is associated.

18. In a telephone system, according to claim 11, means effective immediately upon determination of the zone within which the called line is located for causing the release of the auxiliary selector switches succeeding the one with which said timing switch is associated.

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