Oct. 14, 1930. W. W. CARPENTER ET AL 1,778,309

TELEPHONE METERING SYSTEM

Filed May 31, 1929 4 Sheets-Sheet 1

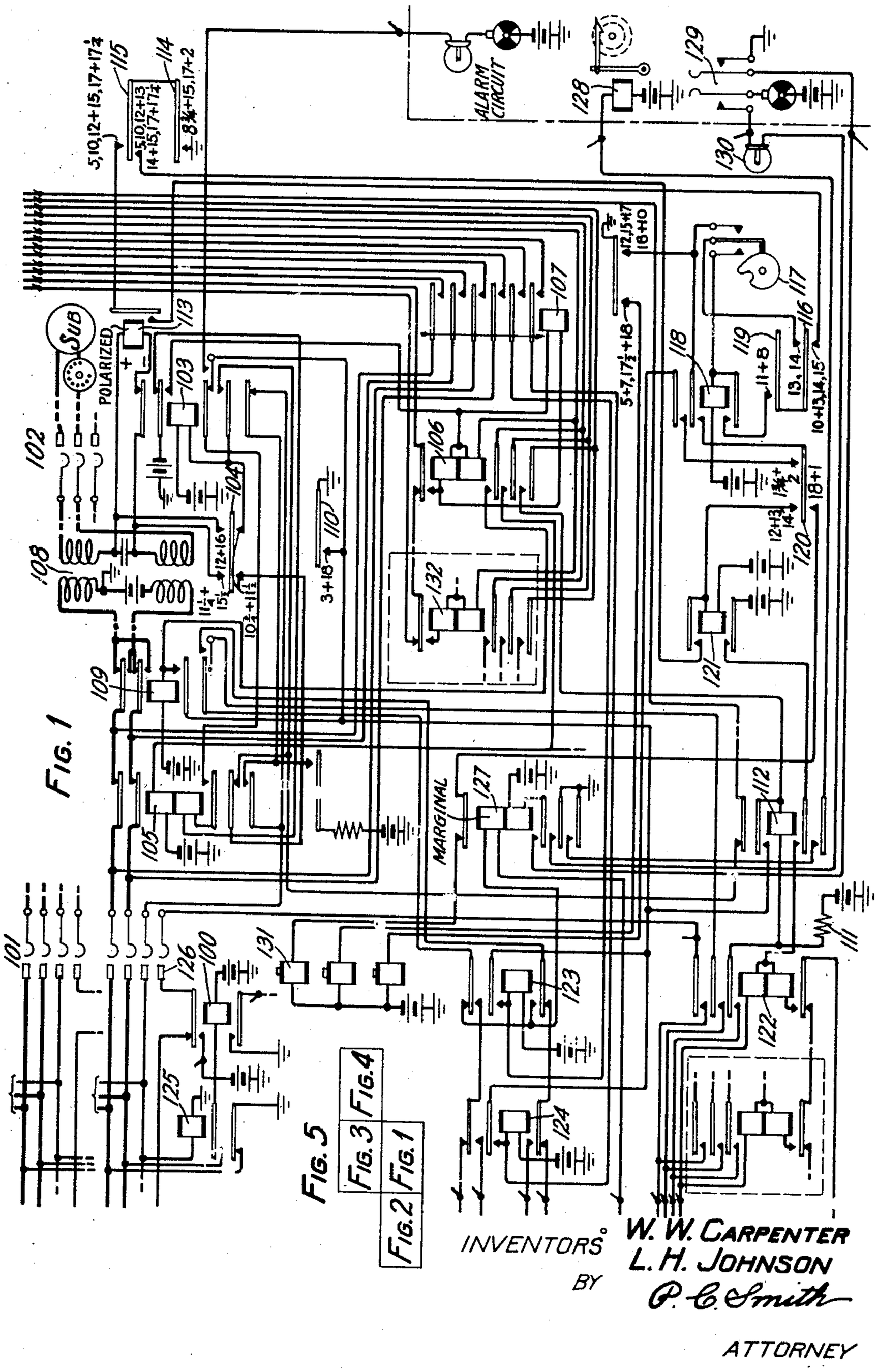

FIG. 1

FIG. 5

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

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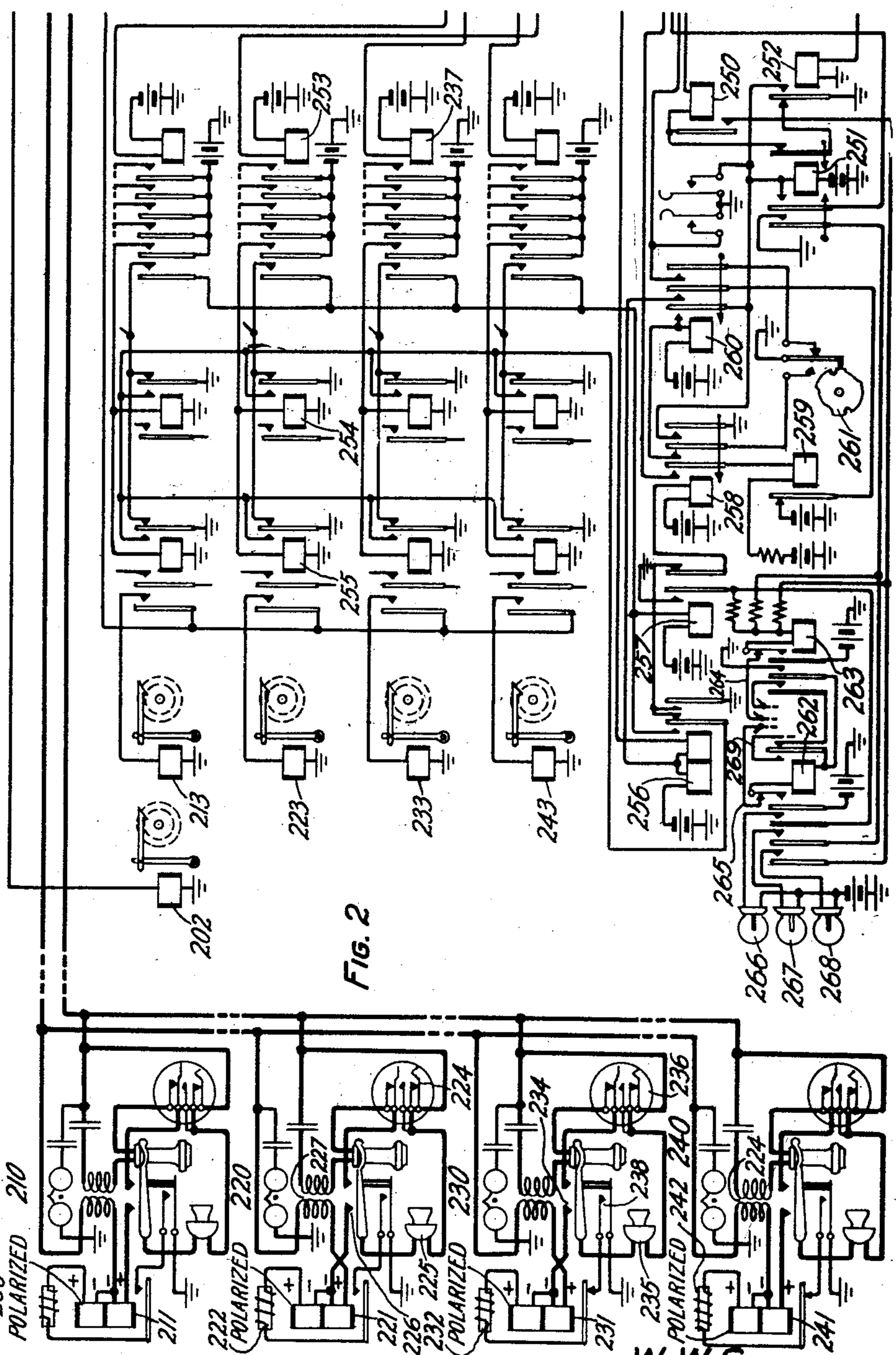

FIG. 2

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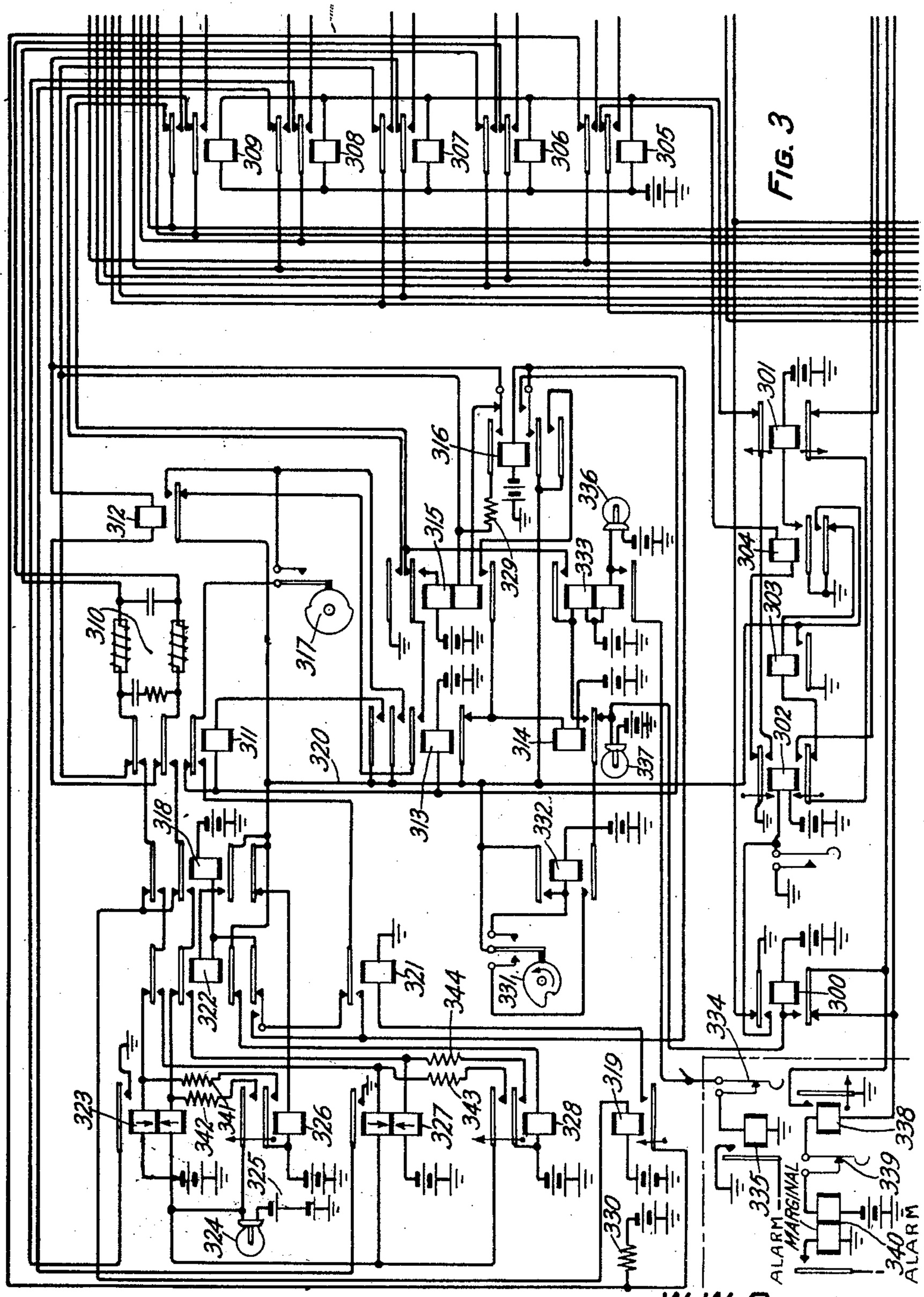

FIG. 3

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TELEPHONE METERING SYSTEM

Filed May 31, 1929 4 Sheets-Sheet 4

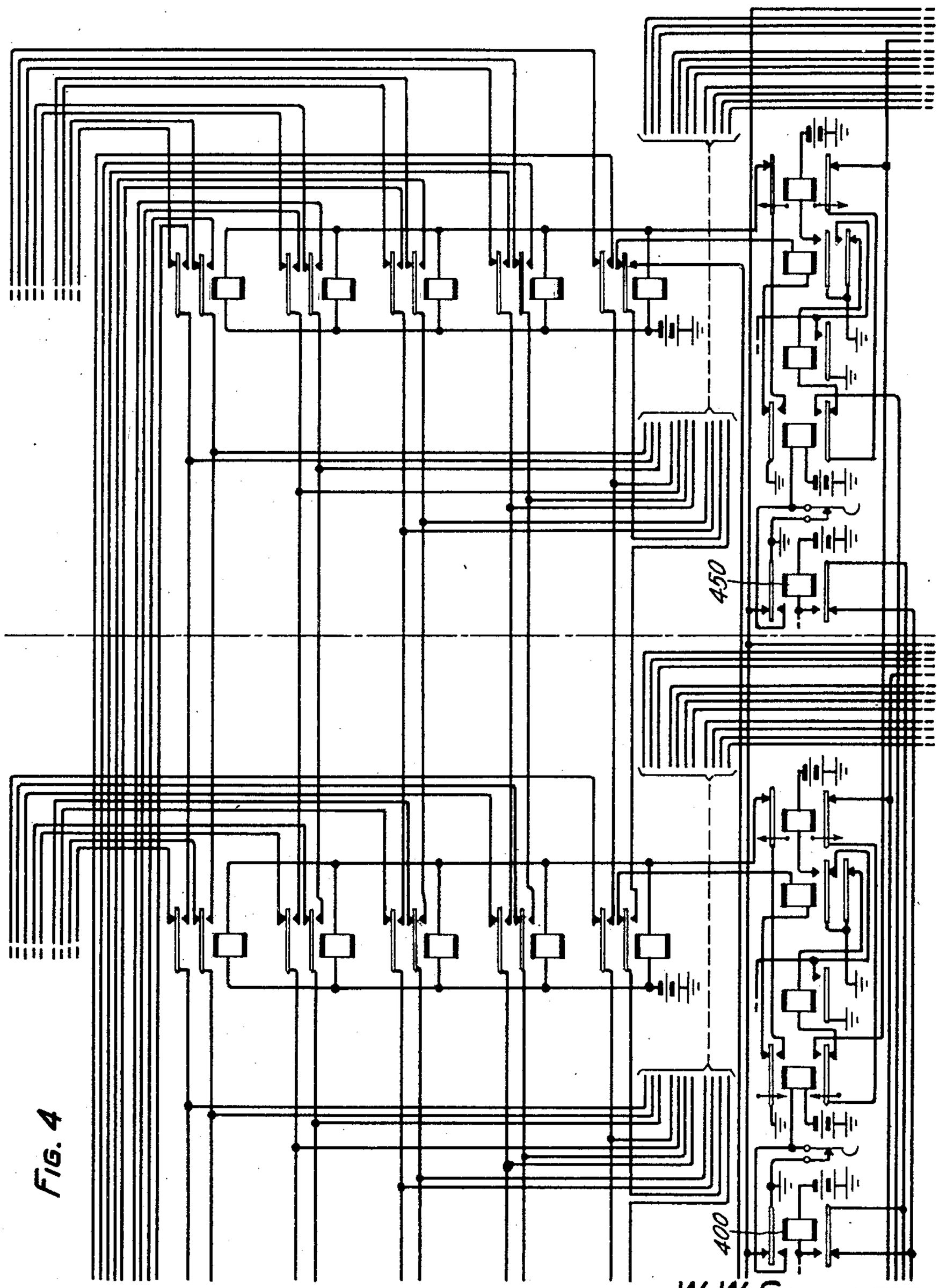

FIG. 4

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UNITED STATES PATENT OFFICE

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TELEPHONE METERING SYSTEM

Application filed May 31, 1929. Serial No. 367,259.

This invention relates to dial telephone systems, and more particularly to metering calls on multi-party telephone lines. The object of the invention is increased economy and efficiency in the apparatus necessary for this purpose.

The embodiment of the invention chosen for the purpose of illustration comprises a meter control circuit common to the lines appearing in a particular finder frame and to the district selectors serving such lines. The lines are each provided with a single metering terminal. The meter control circuit can be associated with any district selector for the purpose of supplying metering current to a calling line. In the control circuit is a plurality of sets of multi-contact relays, each set serving to connect a particular party meter to the metering terminal of each line in the group. Responsive to the connection of the party meter to the metering terminal of the calling line, metering potential is connected by way of the district selector and line finder to the metering terminal. After a measured interval the meter control equipment is disconnected from the selector. The control equipment is so arranged that in the case of an individual line where the meter is connected directly to the metering terminal, in which case no registration is set up in the district selector, application of metering current is rendered independent of the connecting relays. Likewise means is provided to discriminate between the condition where the lack of registration is due to the calling line being an individual line and that due to a fault in the setting up of the registration. In the latter case the circuit is arranged to indicate on a meter that no registration was made and means is also provided in the selector whereby this no registration condition can be made to operate an alarm.

The invention will be more clearly understood from a consideration of the following description in connection with the attached drawings in which Fig. 1 shows a portion of a district selector, Fig. 2 shows a four-party line, an individual line, and the common meter control equipment, Fig. 3 shows one complete party identification circuit, Fig. 4 shows portions of two other identification circuits, and Fig. 5 is a diagram indicating the manner in which the other figures should be arranged.

Briefly, when a call is initiated the calling line is associated with a district selector by any suitable means, for example, a line finder. The district selector is then associated with an idle sender and the wanted line number is recorded in the sender which thereupon controls the selective operations of the district selector and other switches. When selections have been completed a relay is operated which connects an idle identification circuit with the calling line. The operation of this relay connects a network in parallel with a section of the talking circuit as it extends through the district selector and then opens the talking circuit to insert the network therein. The identification circuit then connects a relay to both sides of the line in parallel to determine whether the substation calling is grounded and then in effect applies battery first to one side of the line and then to the other to operate the polarized relay at the substation which, by its response, determines the registration. Following the registration the line is reclosed and the identification circuit is disconnected from the selector. When the called subscriber answers and the charge relay operates as an indication that the call has been successful, a meter control circuit is associated with the district selector under the control of the registration set up by the identification circuit. The meters of the corresponding party of all lines located on the same frame are connected to the respective metering terminals of the line. For example, if the calling substation were substation #1, then the #1 meter for every party line appearing in the same panel would be connected to the metering terminal of the corresponding line. This operation initiates the application of metering current to the metering terminal for a measured interval after which the current is removed and the meter control circuit disconnected from the district selector.

Assuming that the subscriber at substation 220 initiates a call, removal of the re-

ceiver from the switchhook at the substation actuates the line relay 100, thus initiating the operation of a trip, start and link circuit. These circuits in turn bring about the operation of a particular line finder and district selector for the purpose of extending the call. The line finder, for example line finder 101, connects with the calling line, after which the line is associated with a sender. The operation of the dial on the calling line registers the number of the wanted subscriber in the sender in accordance with which the sender controls the operation of the district selector 102 and other switching apparatus for completing the connection. The sequence of operations of the district selector is guided by a sequence switch which advances from position to position as the circuit functions. Since the foregoing operations are merely incidental to the present invention, no attempt has been made to either show or describe the apparatus and its functions in detail. Reference is hereby made to U. S. Patent 1,589,402, granted January 22, 1926 to O. H. Kopp, for a detailed description of the establishment of a connection through equipment of the type shown.

As set forth in the above identified patent, the operations of the line finder 101 and district selector 102 take place in positions 1 to 9 inclusive of the sequence switch while those of the switching apparatus to which the district selector has access, take place with the district selector sequence switch in position 10. When the selections have been completed, indication of this is returned to the sender which advances the district selector sequence switch from position 10 to position 12. As soon as the sequence switch leaves position 10, a circuit is closed from battery, through the winding of relay 103, lower contacts of sequence switch cam 104, lower back contact of relay 105, upper back contact of relay 112, to ground at the back contact of relay 300. This circuit also extends to ground at the back contact of relays 400 and 450 so that should relay 300 be operated because of a failure of the identification circuit, as will be described hereinafter, relay 103 will nevertheless be operated. Relay 103 locks over its lower front contact and the back contact of relay 112 to ground at the back contact of relay 300, thus rendering itself independent of the sequence switch and of relay 105. Relay 103 in operating closes a circuit from battery, through its upper front contact, lower winding of relay 106, lower back contact of relay 301, lower back contact of relay 302, winding of relay 303, lower back contact of relay 304, to ground. Relay 106 operates, locking through its upper winding and over its upper front contact, inner back contact of relay 305, winding of relay 304, upper back contact of relay 302 to ground. The closure of the upper contact of relay 106 also completes a circuit in parallel with the upper winding of relay 106 for relay 107 which also operates after an interval. Relays 106 and 107 are held operated independent of the position of the district sequence switch so that talking selections and conversation may proceed while the identification is being made. Relays 106 and 107 complete connections from the identification circuit to the district selector. The four uppermost contacts of relay 107 serve to connect network 310 in parallel with a portion of the talking circuit, namely, that part passing through the contacts of relay 105. These circuits may be traced:—from the tip brush of the line finder, fourth contact of relay 107, upper back contact of relay 306 to the upper right terminal of the network, through the upper retardation coil, uppermost back contact of relay 311, upper back contact of relay 307, sixth contact of relay 107, to the tip conductor of the talking circuit at a point beyond the contact of relay 105; from the ring brush of the line finder, third contact of relay 107, inner back contact of relay 306, to the lower right terminal of the network 310, lower retardation coil, middle back contact of relay 311, through the winding of relay 312, inner back contact of relay 307, fifth contact of relay 107 to the ring conductor at the right of the contact of relay 105. By the same operation the lower winding of relay 315 is bridged across the repeating coil of the district selector completing a circuit from battery through the lower left winding of repeating coil 108, inner upper back contact of relay 109, fifth contact of relay 107, inner back contact of relay 307, upper normal contact of relay 316, lower winding of relay 315, upper back contact of relay 307, sixth contact of relay 107, upper back contact of relay 109, upper left winding of repeating coil 108 to ground. Relay 315 operates in this circuit and initiates the testing of the calling line. The operation of relay 315 completes a circuit from ground at its upper front contact, inner back contact of relay 309, middle lower front contact of relay 106, upper winding of relay 105 to battery. Relay 105 operates, opening the talking circuit at its contacts and thus introducing the network 310 into the talking circuit so that the subsequent test may produce no unpleasant clicks or other noises to disturb the conversation. With the inclusion of the network in the talking circuit relay 312 is included in a circuit fed by battery through the repeating coil 108 and extending over the subscriber's line. in which circuit relay 312 operates provided the conductors connecting the identification circuit and the district selector as well as the subscriber's line are uninterrupted.

The closure of the locking circuit of relay 106 causes the operation of relay 304 which in turn operates relay 301 to prevent the

transfer of the call to another identification circuit. Relay 304 also closes a circuit over its lower front contact, lower back contact of relay 313, winding of relay 314 to battery, preparing a timing circuit for determining whether the tests are completed properly. It also connects ground over conductor 320 to the armature of relay 312.

Assuming that relay 312 operates, a circuit is closed from battery, through the winding of relay 313, lowermost back contact of relay 311, contact of interrupter 317, front contact of relay 312 to grounded conductor 320. Relay 313 locks through the winding of relay 311, over the upper front contact of relay 313 to grounded conductor 320. Relay 311 does not operate until interrupter 317 opens its contact to open the shunt around the winding of relay 311. When relay 311 operates the subscriber's line is disconnected from the repeating coil but relay 315 remains bridged across the repeating coil holding the connection. The two sides of the subscriber's line are then extended over the upper front contacts of relay 311 and the back contacts of relay 318 to the winding of relay 319 and battery, to determine whether the calling party is one identified by ground.

Examining Fig. 2 for a moment it will be apparent that each party 210, 220, 230, and 240 has a polarized relay and a grounded contact associated with the substation. With the receiver removed from the switchhook the substations 210 and 220 are not grounded while substations 230 and 240 have ground connected through the winding of the polarized relay to the line. In the case of substation 230 the ground extends over an auxiliary contact of the switchhook, back contact of polarized relay 231, retardation coil 232, upper winding of polarized relay 231, through the switchhook, transmitter and dial contact 236 to the ring conductor, and through both windings of the polarized relay and one winding of the substation repeating coil to the tip conductor. In the case of substation 240 the ground extends over the auxiliary contact of the switchhook, back contact of relay 241, retardation coil 242, upper winding of relay 241, left winding of coil 244 to the tip conductor while it extends through both windings of the polarized relay through the switchhook, transmitter and dial contacts to the ring conductor. Since the subscriber at substation 220 was assumed to be calling ground will not be connected to either tip or ring conductor and relay 319 will not be operated. It should be noted that the battery connected to relay 319 is the reverse of that used elsewhere so that it has no effect on the polarized relays at the substations.

The next closure of the contact of interrupter 317 completes a circuit from grounded conductor 320, middle front contact of relay 313, contact of interrupter 317, lower front contact of relay 311, back contact of relay 321, lower back contact of relay 322, winding of relay 318 to battery. Relay 318 operates and locks through the winding of relay 322 and the lower front contact of relay 318 to grounded conductor 320 but relay 322 does not operate until interrupter 317 opens its contact. When ground was connected to conductor 320 a circuit was also closed over the lower back contact of relay 318 to the winding of relay 326 and battery. Therefore, the operation of relay 318 extends the tip conductor of the subscriber's line over the front contact of relay 311 front contact of relay 318, back contact of relay 322, to the upper winding of relay 323 and battery and in parallel through resistance 341 and the inner upper front contact of relay 326 to battery. It also extends the ring conductor over the middle front contact of relay 311, inner upper front contact of relay 318, inner upper back contact of relay 322, through the lower winding of relay 323, to battery 325, through lamp 324 and in parallel with the winding of relay 323, through resistance 342 and the upper front contact of relay 326. Battery 325 is the usual coin battery and has a value of approximately 110 volts while the battery connected to the upper winding of relay 323 is approximately 50 volts. The net result of the use of these two batteries is the same as though one 50 to 60 volt battery were connected to the side of the line to which the coin battery is connected. The purpose served by using the two batteries will be apparent hereinafter. The operation of relay 318 opens the circuit of relay 326 which is slow to release and, therefore, after a short interval opens the shunts closed through its contacts around the windings of relay 323. This, therefore, permits the polarized relay in the substation to operate, if it is going to, before relay 323 becomes effective. In the present case polarized relay 221 operates since it is so connected and polarized as to respond to negative battery applied to the ring conductor. When relay 221 operates it connects ground over the auxiliary switchhook contact, front contact of relay 221, through retard coil 222, upper winding of relay 221, contact 226, transmitter 225, dial contact 224 to the ring conductor. It also connects ground over the switchhook contact, front contact of relay 221, retardation coil 222, both windings of polarized relay 221, winding of repeating coil 227 to the tip conductor. Therefore, when relay 326 releases opening the shunts around the windings of relay 323, this ground unbalances the circuit of differential relay 323 so that the relay operates and closes a circuit from ground, over its front contact, inner back contact of relay 308, innermost lower front contact of relay 106, winding of relay 109 to battery. Relay 109

operates and locks over sequence switch cam 110 to ground. It is to be noted that the windings of relay 323 are so proportioned that the current flowing through them from 110 volt battery 325, over a loop at the subscriber's substation, to central office battery connected to the upper winding of relay 323 maintains the relay unoperated whereas with ground connected to the circuit at the substation, the current through one winding is reversed and results in the operation of the relay. The same holds true of relay 327.

At the time that relay 326 was operated a circuit was closed from battery, through the winding of relay 328, inner lower back contact of relay 322 to grounded conductor 320. Therefore, when relay 322 operates following the opening of the contact of interrupter 317, the tip conductor of the calling line is extended over the outer upper front contacts of relay 311, 318, and 322, the upper winding of relay 327, and in parallel therewith through resistance 343 and the upper front contact of relay 328, through lamp 324 to 110 volt battery 325. The ring conductor is extended over the inner upper contacts of relays 311, 318 and 322 to central office battery through the lower winding of relay 327 and in parallel therewith through resistance 344 and the inner front contact of relay 327 to central office battery. As in the case of relay 323 relay 327 cannot operate with its winding shunted in this manner. The operation of relay 322 opens the circuit of relay 328 and when this relay releases after an interval the windings of relay 327 are connected directly to the line. Since the polarized relay 221 responds only to battery over the ring conductor it does not operate at this time and, therefore, does not connect ground to the line, leaving relay 327 unoperated.

The next closure of the contact of interrupter 317 completes a circuit from conductor 320, front contact of relay 313, contact of interrupter 317, innermost front contact of relay 311, back contact of relay 321, lowermost front contact of relay 322, winding of relay 316 to battery. Relay 316 operates and locks to conductor 320. It also connects ground from conductor 320, over its innermost lower contact to the winding of relay 313, holding that relay operated but shunting relay 311 which releases restoring the connection between the repeating coil 108 and the calling line. Relay 312 reoperates. Relay 316 also closes a circuit from battery, through the winding of relay 314, lower front contact of relay 315, lowermost front contact of relay 316 to grounded conductor 320. The operation of relay 312 opens the locking circuit of relay 315 and the operation of relay 316 connects resistance 329 in parallel with the operating winding of relay 315, thus releasing relay 315. The release of relay 315 opens the circuit of relay 105 and that relay releases restoring the talking circuit to its normal condition. The release of relay 315 also opens the circuit of relay 314. The reclosure of the talking circuit shunts the winding of relay 312 which now releases. A circuit is now closed from battery, through resistance 111, winding of relay 112, lowermost front contact of relay 106, upper back contact of relay 309, upper back contact of relay 315, innermost front contact of relay 313, back contact of relay 312 to grounded conductor 320. Relay 112 locks over its inner upper front contact to ground over cam 110. The operation of relay 112 opens the locking circuit of relay 103 and that relay releases in turn releasing relays 106 and 107, followed by the release of relay 304. The release of relay 304 disconnects ground from conductor 320, thus releasing relays 313, 316, 318, 322 and 301.

When the called subscriber answers polarized relay 113 operates in the well known manner. A circuit is thereupon completed from ground, over cams 114 and 115, front contact of relay 113, cam 116, left contact of interrupter 117, winding of relay 118 to battery. Relay 118 operates and locks over cams 119 and 116, front contact of relay 113, cams 115 and 114 to ground. When interrupter 117 closes its right hand contact a circuit is closed from ground as previously traced, over the inner upper front contact of relay 118, cam 120, winding of relay 121 to battery. Relay 121 locks over its upper front contact and cams 115 and 114 to ground.

At the conclusion of the conversation relay 113 releases in turn releasing relay 118, thus initiating the restoration of the line finder and district selector.

In the meantime with relays 121 and 112 operated a circuit is closed from battery, over the lower front contact of relay 121, inner lower front contact of relay 112, upper winding of relay 122, winding of relay 250, back contact of relay 251, back contact of relay 252 to ground, assuming that the meter control circuit is idle. Relay 250 operates momentarily, but relay 122 locks through its lower winding and front contact to the winding of relay 252 which operates opening the energizing circuit for all relays such as relay 122 and releasing relay 250. Relay 252 also closes a circuit from ground, through its front contact, winding of relay 251 to battery. Relay 251 operates and closes a circuit from ground at the front contact of relay 252, inner left front contact of relay 251, middle upper front contact of relay 122, alternate contact of relay 109, since relay 109 was operated as above described lowermost back contacts of relays 123, and 124, winding of relay 253 to battery.

Relay 253 is one of four party relays each of which is individual to one of the four parties connected to a party line. For ex-

ample, relay 253 is individual to the second party and relay 237 is individual to the third party. The line finder and district selector of Fig. 1 is arranged to serve a maximum of four hundred lines. As will appear hereinafter these lines may be either individual lines or party lines. If all of the lines served by this line finder are party lines, it is necessary that each party relay prepare circuits for four hundred meters. Consequently, each party relay is arranged to operate ten multi-contact relays each of which in turn controls forty contacts. Where individual lines appear on the same line finder frame with party lines, the corresponding contacts of the multi-contact relays need not be equipped. The operation of relay 253, therefore, by operating the multi-contact relays 254, 255, etc., prepares circuits for all of the second party meters belonging to the party lines served by the district selector of Fig. 1.

The operation of relays 255 and 254 closes a circuit from ground, over their right front contacts, right back contact of relay 256, right back contact of relay 257, winding of relay 258 to battery. Relay 255 also prepares a circuit from ground through the winding of message register 223, outer left front contact of relay 255, back contact of line relay 100 (which is now deenergized having been released by the operation of cut-off relay 125 when the line was found in the well known manner), to the metering terminal 126 of the calling line. The circuit may be further traced over the line finder brush, uppermost front contact of relay 122, inner right front contact of relay 258, winding of relay 259 to battery. Relay 259 operates for a purpose which will be described hereinafter. The operation of relay 258 also closes a circuit from battery, through the winding of relay 260, middle front contact of relay 258, left contact of interrupter 261. When interrupter 261 closes this circuit relay 260 operates, locking over its inner front contact to ground at the front contact of relay 252. When interrupter 261 closes its right contact it completes a circuit from ground, over the outer front contact of relay 260, innermost upper front contact of relay 122, resistance 111 and battery. This shunts the winding of relay 112 and that relay releases opening the circuit of relay 122 in turn releasing relay 252, and restoring the meter control circuit to normal. Since the operating circuit of relay 112 was closed through the contact of relay 106, which is now released, it is impossible to make a second charge irrespective of the length of the conversation although it is obvious that there is nothing in the present inventive idea which would prevent its adaptation for repeated charging under the control of the proper equipment.

Had the subscriber at substation 230 been calling the removal of his receiver would have connected the ground over contact 238, back contact of relay 231, retardation coil 232, upper winding of relay 231, switch-hook contact 234, transmitter 235, dial contact 236 to the ring conductor and through both windings of relay 231, left winding of the repeating coil to the tip conductor. When therefore, relay 319 is connected to the tip and ring conductors as above described this relay operates. Relay 319 in operating closes a circuit from ground through the winding of relay 321, contact of relay 319, upper back contact of relay 305, innermost contact of relay 107, through the winding of relay 124 to battery. Battery through resistance 330 is connected in parallel with relay 124, thus insuring the operation of relay 321. When relay 124 operates and locks over its inner upper front contact and the bottom contact of cam 110, this locking ground is connected in shunt of resistance 330 and battery, releasing relay 321. With relay 321 operated the interrupted ground controlled by interrupter 317 is transferred from the winding of relay 318 to the winding of relay 316 so that if relay 124 does not operate before the next closure of interrupter 317, the identification circuit will be dismissed and no registration will be set up in the district, resulting in a free call.

If the registration is made correctly the remaining tests are made as above described. Relay 231 is polarized to respond to battery connected to the ring conductor. Therefore, when relay 318 operates connecting battery 325 to the ring conductor, relay 231 operates disconnecting the ground at its back contact from the line. When relay 326 releases opening the shunt around the winding of relay 323 the current flow through that relay prevents its operation. When battery 325 is connected to the tip of the line by the operation of relay 322, relay 231 does not operate and the ground remains connected to the line. Therefore, when the shunts are removed from relay 327, this ground causes the operation of relay 327 closing a circuit from ground, over the front contact of relay 327, upper back contact of relay 308, second front contact of relay 107, winding of relay 123 to battery. Relay 123 locks over its inner upper front contact to the lower contact of cam 110. When the registration equipment functions the meter selecting circuit may be traced from ground, over the outer right front contact of relay 258, inner left front contact of relay 251, middle upper front contact of relay 122, normal contact of relay 109, upper front contacts of relays 123, and 124, winding of relay 237 to battery. Relay 237 operates and connects the third party meter 233 to the metering terminal of the line ready

to receive metering potential as previously described.

In the case of substation 210, relay 211 responds to battery connected to the tip conductor and connects ground over its front contact to the line operating relay 327 and in turn relay 123. In the case of substation 240 since the operation of the hook switch connects ground to the line, relay 319 is operated in the manner described for substation 230 in turn operating relay 124. Relay 241 does not respond to heavy battery connected to the ring conductor and, therefore, the ground which remains connected to the line operates relay 323 in turn operating relay 109. Relay 241 does respond to battery connected to the tip conductor, and removes the normal ground thereby preventing the operation of relay 327.

To summarize:

If substation 210 calls, registration relay 123 operates.

If substation 220 calls, registration relay 109 operates.

If substation 230 calls, registration relays 124 and 123 operate.

If substation 240 calls, registration relays 124 and 109 operate.

Relay 109 serves the added purpose of reversing the direction of current flow through the substation so that the ground will be removed from the line during conversation. In the case of substation 220 it prevents the operation of relay 221 while in the case of substation 240 it causes the operation of relay 241 to remove the ground.

The meter control equipment is especially arranged so that it is possible to place party lines and individual lines on the same frames, so far as metering is concerned. An individual line will not be provided with a polarized relay, grounded contact and a choke coil such as shown in connection with the party line. Since there is no ground at any point of the test none of relays 109, 123 or 124 is operated. The meter selecting circuit extends from ground over the front contact of relay 252, inner left front contact of relay 251, middle front contact of relay 122, normal contact of relay 109, upper back contact of relay 123, upper winding of relay 127, windings of relay 256 to battery. Relay 256 operates and closes a circuit from battery, through the winding of relay 258, right back contact of relay 257 to ground at the outer right front contact of relay 256. It also closes a circuit from battery, through the winding of relay 259, inner front contact of relay 258, uppermost contact of relay 122, to the metering terminal of the individual line, over the back contact of the line relay (not shown) and the winding of message register 202 to ground. Relay 258 also prepares a circuit from battery, through the winding of relay 260, middle front contact of relay 258, to the left contact of interrupter 261. When interrupter 261 closes that contact relay 260 operates and locks to ground at the outer front contact of relay 258. Relay 260 prepares a circuit from ground, over the right contact of interrupter 261, outermost contact of relay 260, inner front contact of relay 122, to resistance 111 and battery, thus releasing relay 112, and terminating the registration in the manner previously described.

In order to discriminate between a lack of registration because the line tested in an individual line and one due to faulty operation of the identification equipment, the winding of relay 127 is introduced in the circuit of relay 256 as above described. If the line is an individual line the message register will be connected directly to the metering terminal and relay 259 will operate in series therewith. If the lack of registration is due to faulty functioning relay 259 cannot operate. Therefore, when relay 260 operates battery is connected over the back contact of relay 259, middle front contact of relay 260, in shunt of the high resistance winding of relay 256, thus reducing the resistance in series with relay 127. Relay 127 is marginal and cannot operate as long as the high resistance winding of relay 256 is in its circuit. With this winding shunted relay 127 operates and closes a circuit over its lowermost contact, lowermost contact of relay 112, to the meter 128. A record is, therefore, set up of the number of times that the equipment fails to register. This meter is common to the district selectors served by the identification equipment. If the number of failures recorded appears excessive, key 129 may be operated, locking relay 127 and flashing lamp 130 so that the identity of the district selector may be determined. Relay 127 also opens the circuit of down drive magnet 131 of the line finder, preventing its restoration to normal and thus indicating the line with which the trouble arose.

Relays 262 and 263 serve to cause an alarm in case the meter control circuit does not operate properly. Battery is intermittently connected to conductor 264 and the winding of relay 263 and after a measured interval is connected to conductor 265 and the winding of relay 262. The circuit of relay 263 extends to ground over the contact of relay 250 and the back contacts of relays 251 and 252 if relay 121 does not lock. It extends to ground over the front contact of relay 251 during the selecting and operation of the meters and also extends to ground over the front contact of relay 257 if the meter connecting relays such as relays 254 and 255 fail to operate following the operation of selecting relay 253 or if one of these relays operates falsely in the case of an individual line. When battery is connected to conductor 264 while ground is connected to the other terminal of relay 263, relay 263 operates and locks through its inner front contact as long as the operating ground con-

tinues. If this ground remains long enough, the connection of battery to conductor 265 operates relay 262 in a circuit extending over the middle front contact of relay 263 to ground. Relay 262 locks to battery over its inner left front contact and is held operated under the control of relay 263. With relay 262 operated a circuit is closed for one of the lamps 266, 267 or 268, according to which ground operated relay 263 and an alarm is operated over conductor 269.

Relay 106 is individual to the district selector and a similar relay such as relay 132, etc., is provided for each district selector of the group served by the identification circuit of Figs. 3 and 4. These relays are arranged in sequence and the locking circuit of any relay extends over the back contacts of the relays following it in the sequence. Therefore, if two relays operate at the same time only the lower relay in the sequence can lock and the other district selector must await the release of the identification circuit. If, for any reason, this chain locking circuit is broken so that relay 106, for example, cannot lock, the operation of relay 303 in the energizing circuit of relay 106 prepares a circuit from ground, over the front contact of relay 303, right contact of interrupter 331, winding of relay 332 to battery. Relay 332 locks over its upper front contact to the front contact of relay 303. Relay 303 also closes a circuit from ground, over its front contact, lower contact of relay 313, winding of relay 314 to battery. If relay 106 locks through the winding of relay 304 the circuit of relay 303 is opened at once and relay 332 cannot operate. With relays 332 and 314 both operated the closure of the left contact of interrupter 331 completes a circuit from ground at the front contact of relay 303, left contact of interrupter 331, lower front contact of relay 332, front contact of relay 314, winding of relay 333 to battery. Relay 333 locks through its lower winding and lower front contact, key 334, winding of relay 335 to ground, thus operating an alarm which can only be silenced by the operation of key 334. It also lights lamp 336 to indicate which identification circuit failed. Relay 333 also connects ground over its front contact, uppermost back contact of relay 309, lowermost contact of relay 106, which is operated but not locked, winding of relay 112, resistance 111 to battery. Relay 112 releases relays 102, 106 and 303. Since no registration was set up the call will proceed as a free call. If relay 106 locks, relay 304 operates in the locking circuit, opening the circuit of relay 303. However, relay 304 substitutes ground at its lower front contact for the ground at the front contact of relay 303. Therefore, if the line is open so that relay 312 cannot operate, and in turn relay 313 does not operate, relay 314 remains operated and the alarm operates as above described.

According to the present disclosure three identification circuits are provided to serve a large group of district selectors and each of these normally serves a particular part of the group. Means has been provided, however, so that if one identification circuit fails to function, one of the other identification circuits may be used. If the identification does not take place within a predetermined time relay 332 is operated under the control of interrupter 331 and locks as above described. The operation of relay 313 releases relay 314 so that the subsequent closure of the left contact of interrupter 331 extends ground over the front contact of relay 332, back contact of relay 314, to lamp 337, and winding of relay 300 and battery. Relay 300 extends its operating ground over the back contact of similar relays 400 and 450 of the other identification circuits, through the winding of relay 338, key 339, right winding of relay 340 to battery. Relays 338 and 340 operate, relay 340 sounding an alarm and locking to the alarm circuit. The operation of relay 338 connects ground over its front contact to the armature of relay 300, thus holding relay 300 operated when interrupter 331 opens its contact. Relay 300 also closes a circuit for relay 302. Relay 302 opens the circuit of relay 304 at its upper back contact and when relay 301 releases completes a circuit over the upper front contact of relay 302, back contact of relay 301, through the windings of relays 305, 306, 307, 308 and 309 in parallel to battery. Relays 305 to 309 in operating transfer the circuits which connect the district selector with this identification circuit to the identification circuit shown at the left of Fig. 4. Since both identification circuits indicated on Fig. 4 are identically the same as that shown in Fig. 3, only the transfer and switching relays have been shown.

If the second identification circuit should fail to complete its function in the proper time the same operations will take place and the circuits further extended to the third identification circuit. In case all three fail, the operation of relay 450 of the third identification circuit opens the circuit of relay 338 and releases relays 300, 400 and 450. Calls may also be rerouted from the second identification circuit to the third and first and from the third identification circuit to the first and second in the same way as they were advanced from the first to the third as above described.

If at the completion of the identification tests, relay 312 fails to reoperate, and consequently relay 315 does not release, a circuit is closed for relay 314, over the lower front contact of relay 315, outer lower front contact of relay 316 to grounded conductor 320, thus operating relay 333 and bringing in an alarm through the operation of relay 335. Relay 333 operates relay 112 as before.

It is to be noted that where the failure to make registration is the result of trouble on the part of the line or the district selector, relay 112 is operated and the identification circuit merely dismissed. Where the difficulty is due to the identification circuit an attempt is made to complete the identification by associating the district selector with other identification circuits.

What is claimed is:

1. In a telephone exchange system, a plurality of telephone lines, a plurality of correspondingly designated substations on each line, a meter for each substation on each line, a plurality of selectors, a single metering terminal for each line, a called line, means for establishing a connection to said called line under the control of a substation on one of said lines including one of said selectors, a meter control circuit common to said selectors, means controlled by the response of said called line for connecting said meter control circuit with said selector, said connecting means being effective to render said control circuit individual to the selector to which it is connected, a set of relays in said control circuit for each designation of said substations, said relays serving to connect the meters of all similarly designated substations with the metering terminal of the line on which each substation is located, and means responsive to said connecting means for operating the set of relays for the designation of the calling substation.

2. In a telephone exchange system, telephone lines having a plurality of subscribers' substations located thereon, a single metering terminal for each line, a plurality of selector switches for extending said line, a called line, means responsive to the extension of a call to said called line from one of said substations through one of said selector switches for testing said line and establishing a record in said selector switch of the calling substation, a meter control circuit, means controlled by the response of said called line to associate said meter control circuit with said selector, means in said meter control circuit responsive to the record in the selector switch for connecting the corresponding meter of all the lines to which said selector has access to the metering terminal of the line to which each meter is individual, and means under the joint control of said meter control circuit and said selector to operate the meter of the calling substation.

3. In a telephone exchange system a plurality of party lines, a single metering terminal for each line, a meter for each party on said lines, a plurality of selector switches for extending said lines, a called line, means responsive to the extension of a call to said called line from one of said substations through one of said selector switches for establishing a record in said selector switch of the calling substation, a meter control circuit, means controlled by the response of said called line to associate said meter control circuit with said selector, means under the control of said relay to connect the corresponding meter of each line with the metering terminal of that line and means including said control circuit and said selector for applying metering potential to said calling line to operate the meter of said calling party.

4. In a telephone exchange system, individual lines and party lines, a single metering terminal for each line, a selector for extending connections from said lines, means to test calling lines and to set up a registration in the selector if the calling line is a party line to indicate the party calling, a meter control circuit common to a plurality of selectors, said control circuit comprising means for connecting a party line meter with the metering terminal, means responsive to the connection of the meter with the metering terminal for applying metering current to said metering terminal, and means for discriminating between party lines and individual lines to render said current supply means independent of said meter connecting means in the case of individual lines.

5. In a telephone exchange system, individual lines and party lines, a single metering terminal for each line, a selector for extending connections from said lines, means to test calling lines and to set up a registration of the party calling if the calling line is a party line and no registration if the calling line is an individual line, a meter control circuit common to a plurality of selectors comprising means under the control of the party registration to connect the proper meter with the metering terminal of a calling party line, and means thereupon effective to supply metering current to said metering terminal and other means effective if no registration is set up in the selector to cause the supply of metering current to the metering terminal of the calling line.

6. In a telephone exchange system, individual telephone lines, party telephone lines having a plurality of substations, a selector, means for extending a connection from one of said lines through said selector, means for establishing a record of the calling substation in the case of lines having a plurality of substations and no record in the case of individual lines, means to prevent the establishment of any record if said record is not correctly established, a meter control circuit, and means in said meter control circuit to discriminate in its operation between individual lines and party lines and means to discrimi-

nate between a no record condition due to the calling line being an individual line and a no record condition due to improper recording.

7. In a telephone exchange system, individual telephone lines, party telephone lines having a plurality of substations, a selector, means for extending a connection from one of said lines through said selector, means for establishing a record of a calling substation in the case of lines having a plurality of substations and no record in the case of individual lines, means to prevent the establishment of any record if said record is not correctly established, a meter control circuit, means in said meter control circuit to discriminate in its operation between individual lines and party lines and means to discriminate between a no record condition due to the calling line being an individual line and a no record condition due to improper recording, and means under the control of said discriminating means to record the number of times that a no record condition occurs due to improper recording.

8. In a telephone exchange system, individual telephone lines, party telephone lines having a plurality of substations, a selector, means for extending a connection from one of said lines through said selector, means for establishing a record of a calling substation in the case of lines having a plurality of substations and no record in the case of individual lines, means to prevent the establishment of any record if said record is not correctly established, a meter control circuit, means in said meter control circuit to discriminate in its operation between individual lines and party lines and means to discriminate between a no record condition due to the calling line being an individual line and a no record condition due to improper recording, means under the control of said discriminating means to record the number of times that a no record condition occurs due to improper recording, and manual means to render said discriminating means effective to indicate the selector on which the record was improperly established.

9. In a telephone exchange system, a plurality of party lines, a meter for each party on each line, a plurality of district selectors for extending said lines, a plurality of identification circuits common to said district selectors, a called line, means to establish a connection from a calling line to said called line by means of one of said district selectors, means in said district selector responsive to the establishment of said connection to cause the association of one of said identification circuits with said district selector, means in said identification circuit to test the calling line and to set up a registration in the district selector of the calling party, means effective following the establishment of such record to disconnect said identification circuit from said district selector, a meter control circuit, means controlled by the response of said called line to associate said meter control circuit with said district selector, a relay in said control circuit for each party, means to operate one of said relays in accordance with the registration in the district selector, a single metering terminal for each line, means under the control of said relay to connect the corresponding meter of each line with the metering terminal of that line, and means including said control circuit and said district selector for applying metering potential to the terminal of the calling line to operate the meter of the calling party.

In witness whereof, we hereunto subscribe our names this 28th day of May, 1929.

WARREN W. CARPENTER.
LEWIS H. JOHNSON.