

June 9, 1925.

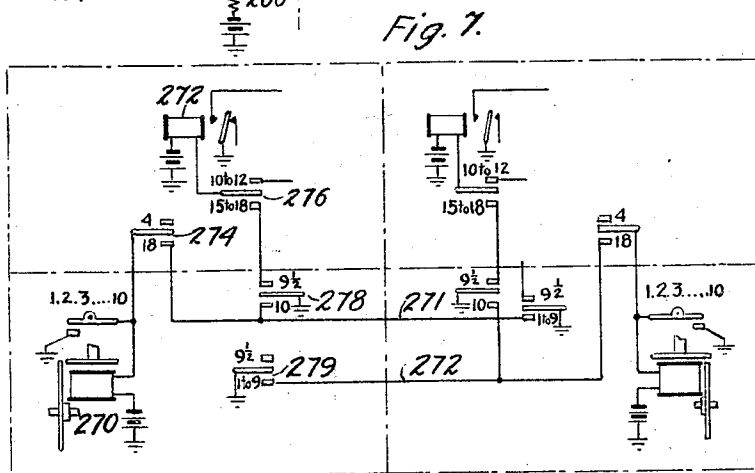
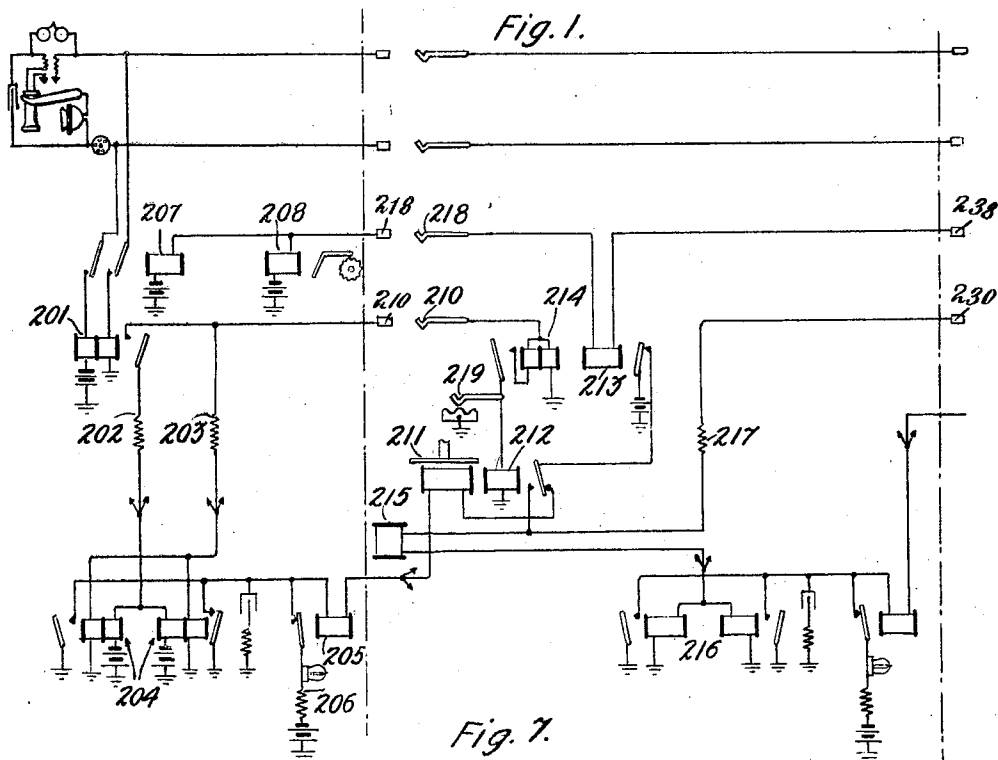
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MACHINE SWITCHING TELEPHONE EXCHANGE SYSTEM

Filed Feb. 6, 1919

5 Sheets-Sheet 1



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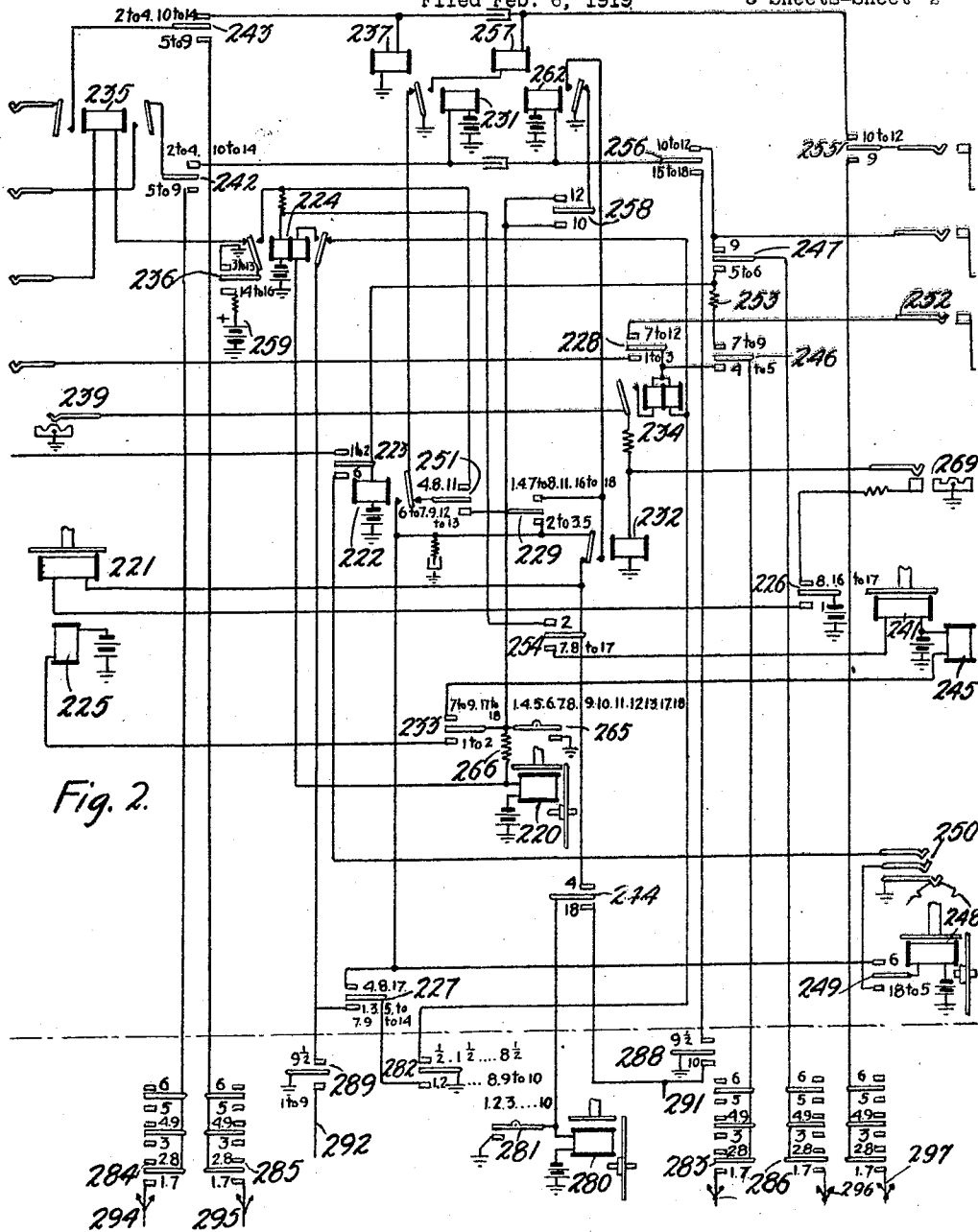
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5 Sheets-Sheet 2



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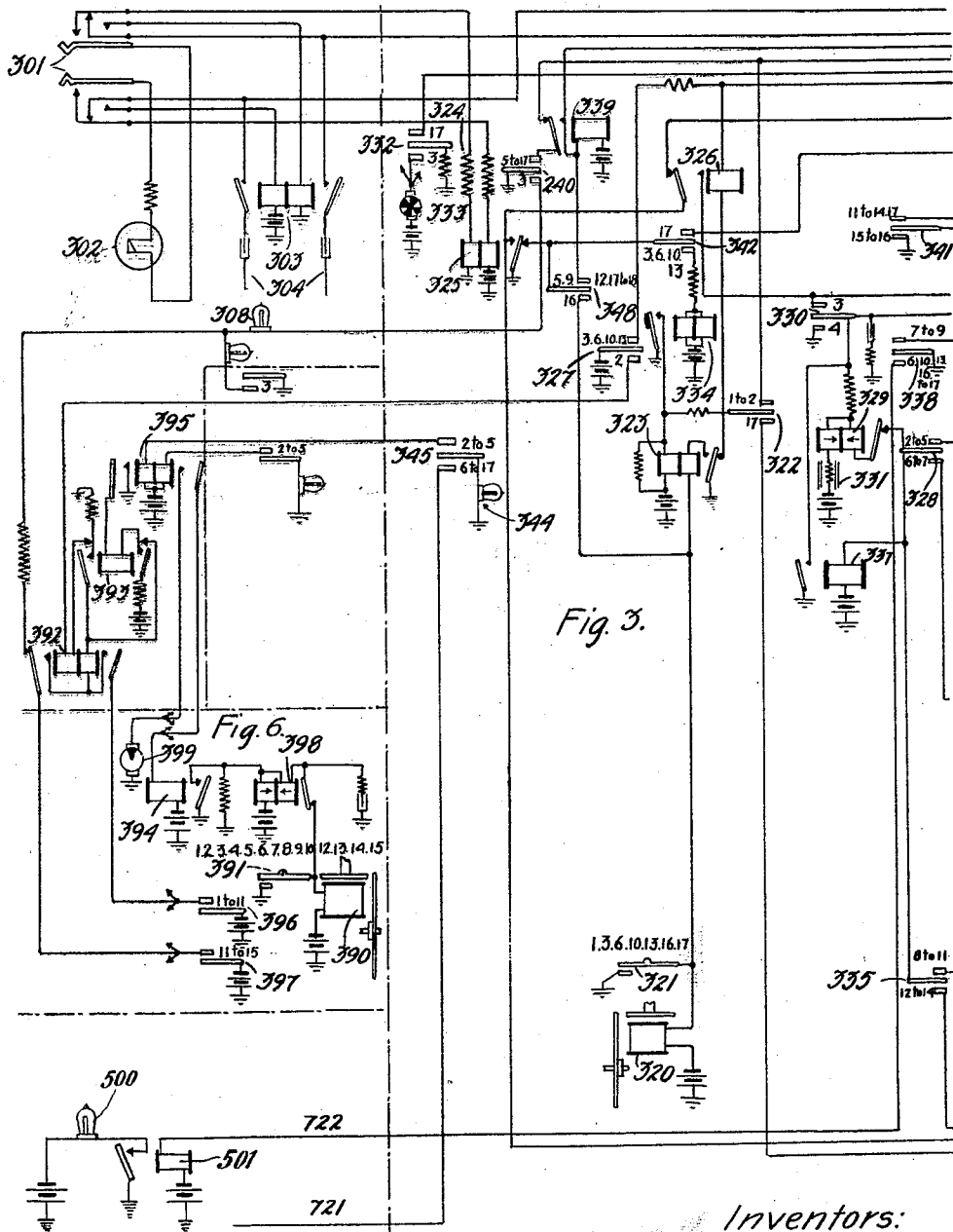


Fig. 3.

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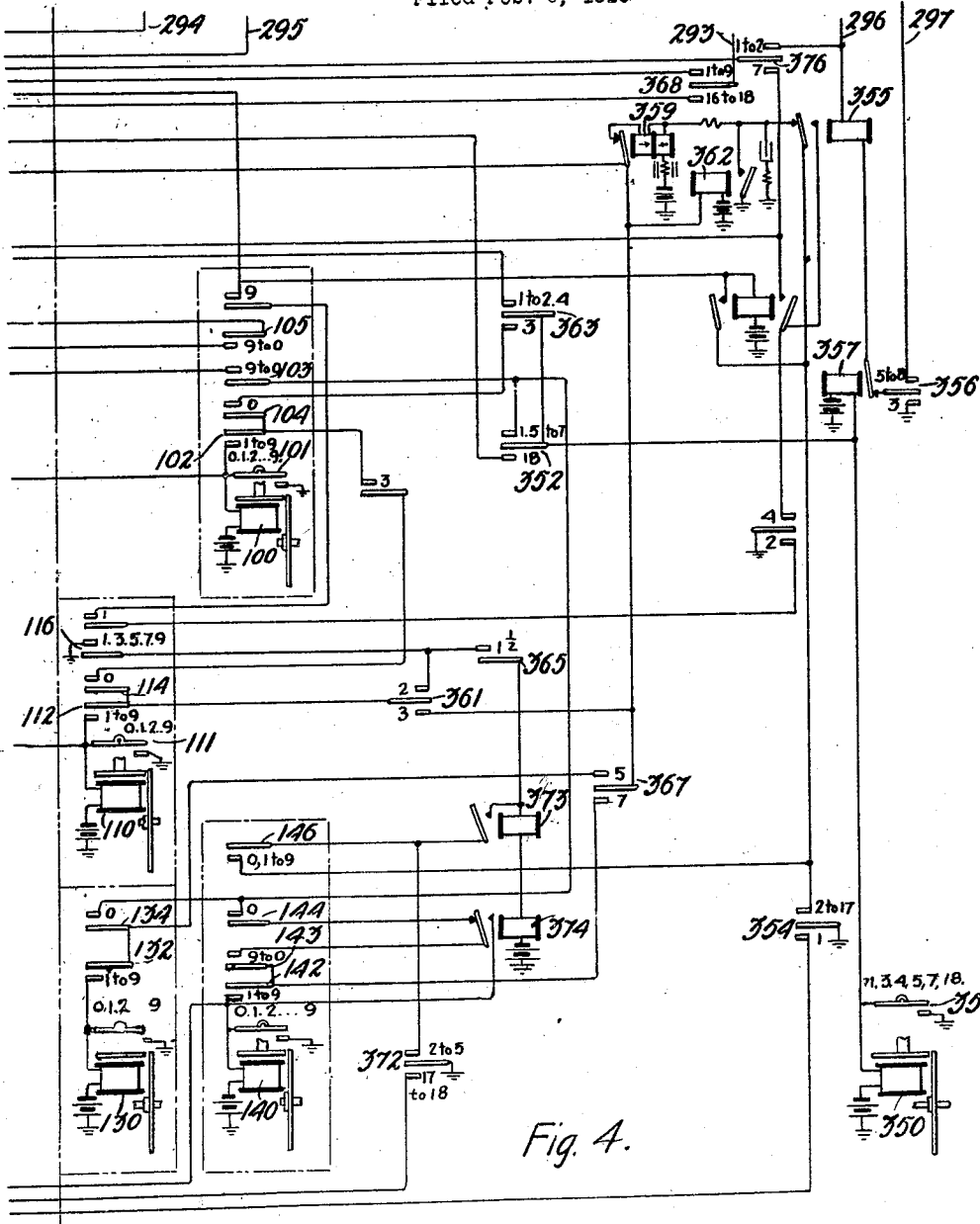


Fig. 4.

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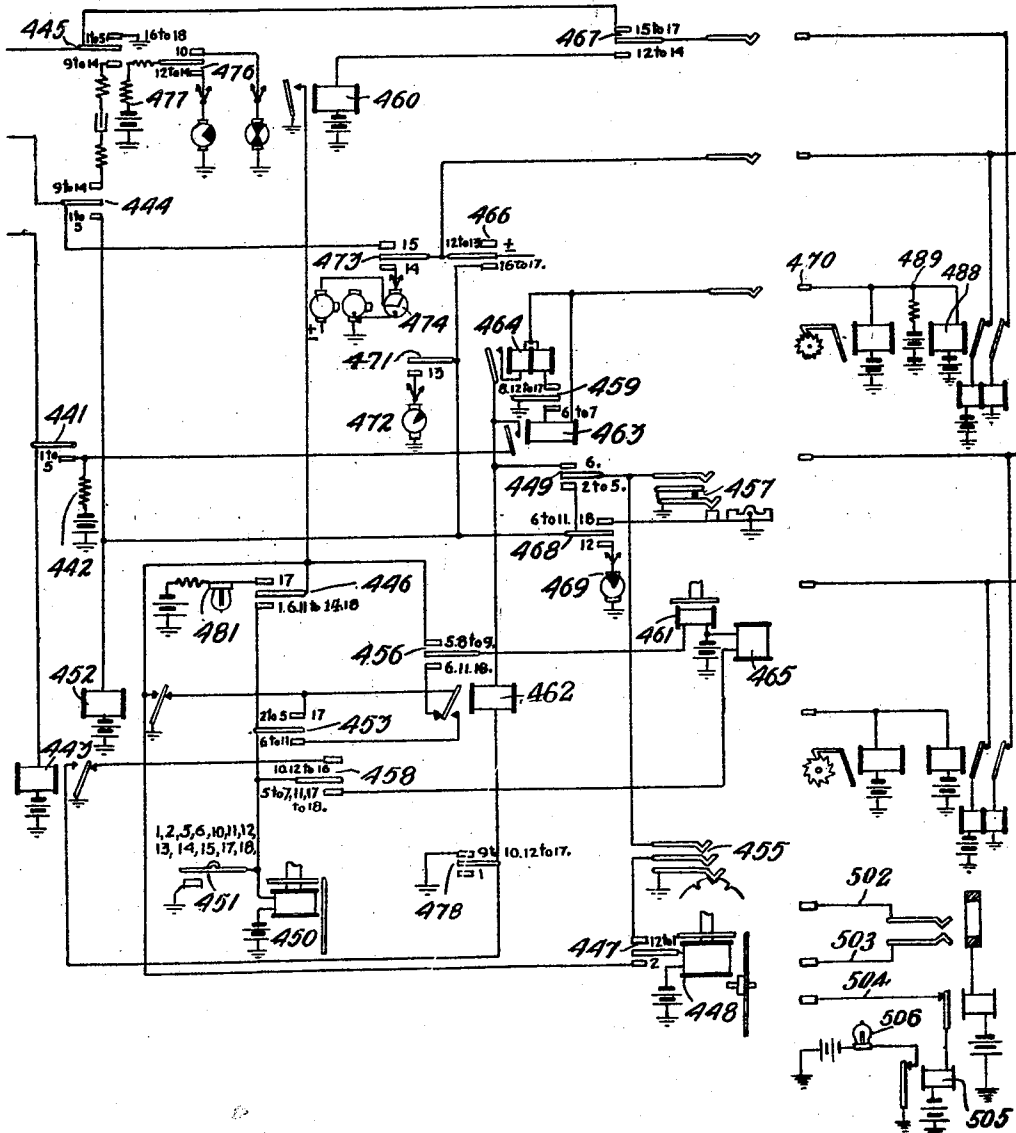
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5 Sheets-Sheet 5

Fig. 5.



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# UNITED STATES PATENT OFFICE.

LIPA POLINKOWSKY, OF NEW YORK, N. Y., AND GERALD DEAKIN, OF LONDON, ENGLAND, ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

## MACHINE-SWITCHING TELEPHONE-EXCHANGE SYSTEM.

Application filed February 6, 1919. Serial No. 275,483.

*To all whom it may concern:*

Be it known that we, LIPA POLINKOWSKY, a citizen of Russia, of 463 West Street, New York, New York, and GERALD DEAKIN, a citizen of the United States of America, of 34 Norfolk Street, Strand, London, W. C., England, have invented certain new and useful Improvements in Machine-Switching Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to machine switching telephone exchange systems, and more particularly to machine switching telephone systems of the full automatic type.

A feature of the invention is the provision, on a register set, of a calling signal which, when a register is engaged with a line but does not receive within a predetermined length of time setting up impulses from the calling substation, appears before an operator to notify her that her connection over the register is required with the calling line.

A further feature relates to an arrangement wherein the registers of the register controlling mechanism take a special setting in response to certain designations sent over the calling line for controlling the extension of such line to an operator's position.

In the drawings:

In Fig. 1 is shown a subscriber line and a first line finder;

Fig. 2 shows a cord circuit comprising a second line finder and a first group selector; Figs. 3 and 4 show a register set;

Fig. 5 shows a final selector;

In Fig. 6 is shown a common arrangement for the timely delay of a monitoring signal; and

Fig. 7 shows diagrammatically the subdivision of cords in pairs.

The system disclosed as embodied in the present invention will be best understood from a description of the operation thereof.

A subscriber, when desirous of obtaining a connection, removes the receiver from the hook, operating thereby the line relay 201 in the exchange. A circuit is then established over the individual resistances 202 and 203 of the subscriber line, the front contact of line relay 201 and both windings of the common starting relays 204, and a po-

tential is created on the corresponding test terminal 210 at the first line finders. Two common starting relays 204 connected in parallel are provided for each line finder group. The relays 204, when energized, provide a circuit for the energization of the guarding relay 205 and the power magnets 211 of the free line finders in the group, the individual circuit of a power magnet 211 being closed over the back contact of the corresponding test relay 212 and disconnecting relay 213. The power magnet 211, when energized, causes in the well-known manner the rotation of the brush carriage of the line finder along the terminals of the subscriber lines. The right-hand high-resistance winding of test relay 214 of the line finder, the brushes of which happen to stay on the terminals of the calling line, or are the first to reach these terminals, is energized in a circuit over terminal 210. The left-hand low-resistance winding of relay 214 is brought over its front contact in parallel to its high-resistance winding, reducing the potential at terminal 210 so that no test relay of another line finder which passes the multiples of this terminal is able to operate. When the brushes are centered and contact 219 of the brush carriage is opened, the second test relay 212 is connected in series with the left-hand winding of relay 214, and also becomes energized. The power magnet 211 is disconnected on the back contact of this relay, and a circuit is closed over its front contact including the holding magnet 215 of the line finder and the common starting relays 216, and a potential is created over resistance 217 on the corresponding test terminal 230 of the second line finders. The brushes of the first line finder in question are arrested on the terminals of the calling line, whereas the brush carriages of the remaining free first line finders in this group continue to rotate. Relay 205 remains deenergized if a call arrives and there is no first line finder free in the group, in which case the common guarding lamp 206 lights in a circuit over back contact of relay 205 and front contacts of relays 204.

Each second line finder, together with a first group selector, represents a cord which is provided with an individual sequence switch 220 for establishing the different circuits in succession, and a searching sequence

switch 280 for obtaining a connection with a free register set. For the purpose of reducing the number of simultaneous rotating second free line finders, the cords are divided in pairs, as shown in Fig. 7, and are arranged so that when both cords are free, one sequence switch 220 is in its position 1, and the corresponding sequence switch of the second cord is in its position 18. Only the second line finder on which the sequence switches 220 of the cord is in position 1 is able to obtain a connection with a calling first line finder.

The energization of the common relays 216 causes the closure of a starting circuit for a group of second line finders which have access to the first line finders in question, the individual circuit for each second line finder being closed over contact 223 top of sequence switch 220 and relay 222. The energization of relay 222 closes a local circuit for the energization of power magnet 221 of the line finder brush carriage, over back contact of release relay 231, front contact of relay 222, back contact of relay 232 and sequence switch 226 bottom. The brushes of the second line finder rotate, and reaching terminal 230, the test relay 234 is energized in a circuit over contact 282 bottom of sequence switch 280, contact 227 bottom of sequence switch 220, right-hand back contact of metering-hindering relay 224, right hand high-resistance winding of relay 234, sequence switch contact 228 bottom, terminal 230, resistance 217, front contact of relay 212 and back contact of relay 213. The left-hand low-resistance winding of relay 234 is brought in parallel to its high-resistance winding over its front contact and contact 239 of the line finder brush carriage. Terminal 230 is made busy for other line finders. When contact 239 is opened the winding of the second test relay 232 is brought in the same circuit, and relay 232 becomes energized, disconnecting on its back contact the power magnet 221, whereas sequence switch 220 is energized in a circuit over its contact 229 top, front contacts of relays 232 and 222 and back contact of relay 231. In parallel to the sequence switch 220 the holding magnet 225 of the line finder is connected over its contact 233 bottom. The brush carriage is arrested on terminal 230, while sequence switch 220 starts from position 1 and moves under the control of its local contact 235 into position 4.

When sequence switch 220 passes position 2, the high resistance winding of relay 234 is disconnected at sequence switch contact 227 bottom, and the energization of relay 234 is maintained over its low resistance winding. When sequence switch 220 reaches position 3 a circuit is closed for the energization of the cutoff relay 207 of the subscriber line, relay 213 of the first line finder

and connecting relay 235 of the cord, the circuit including terminals 218 and 238, left-hand back contact of relay 224 and sequence switch contact 236 top. Relay 207 causes the disconnection of the line relay 201, and this in turn the disconnection of the common starting relays 204, so that the circuit for the power magnet of the still rotating free first line finders is opened and the brush carriages of these line finders are arrested. At the same time the test relays 214 and 212 on the first line finder in use are deenergized and cause the deenergization of the holding magnet 215, the common relays 216 and the relays on the second line finders corresponding to relay 222. The power magnets of the remaining second line finders are then disconnected and the brush carriages of these line finders are arrested. Relay 231 and retardation coil 237 are now connected over sequence switch contacts 242 top and 243 top, and both front contacts of relay 235 with the calling subscriber line, whereby relay 231 is energized.

In position 4 of sequence switch 220 the test relays 234 and 232 are disconnected from terminal 230 at sequence switch contact 228 bottom. The magnet of sequence switch 280 is now energized in a circuit over contact 244 top of sequence switch 220, back contact of relay 232, contact 227 top of sequence switch 220 and contact 282 bottom. Searching sequence switch 280 starts from position 10 and maintains its movement over its local contact 281. Between the positions of sequence switch 280 in which a connection with a register set can be obtained a passing contact 282 top is closed.

Assuming the register set in Figs. 3 and 4 to be free, a connection with this register set is obtained as soon as sequence switch 280 is nearing its position 1. Relay 234 is thereby energized in a circuit over contact 282 top of sequence switch 280, right-hand winding of relay 234, contact 246 bottom of sequence switch 220, contact 283 of sequence switch 280, wire 293, contact 368 top of sequence switch 350, contact 322 top of sequence switch 320 and left-hand winding of relay 323. Relay 234 produces over its front contact the connection of its left-hand winding together with winding of relay 232 in parallel to its right-hand winding before contact 282 is opened, whereby relay 232 at the cord and relay 323 at the register set are energized. Sequence switch 280 is disconnected at back contact of relay 232, but continues its movement until its contact 281 is opened. At the front contact of relay 232 a circuit is prepared for the energization of sequence switch 220, but this circuit is only closed shortly before sequence switch 280 is arrested and its contact 282 bottom is closed. A delay in the energization of sequence switch 220 is gained and so makes certain

that relay 234 is able to maintain its energization over its left-hand winding after contact 282 top has been opened.

Should it happen that the searching sequence switches of two cords simultaneously reach the same test wire 293 of the register set and the corresponding test relays 234 on both cords become energized, they are not able to maintain their energization over their low resistance windings brought in parallel to one another. Time is therefore gained for relay 234 to deenergize, and relay 232 is deenergized before sequence switch 220 can start from position 4. The searching sequence switch of the cord on which the test relays could not maintain their energization continues to rotate and to search for another free register.

Sequence switch 220 when energized starts from position 4 and moves into position 5, in which the subscriber line is disconnected at sequence switch contacts 242 top and 243 top from the release relay 231, and is connected over the same sequence switch contacts, the contacts 284 and 285 respectively of sequence switch 280, wires 294 and 295, and the contacts of rest of the monitoring key 301 individual to the register set on the complaint desk with the secondary windings of the dialing tone coil 324 and the stepping-in relay 325.

The energization of relay 323 on the register set provides a circuit for the energization of sequence switch 320 over front contact and holding winding of relay 323. Sequence switch 320 which controls the change-over in the circuit of the register set for the setting up of the registers from the subscriber's dial, starts from position 1 and moves under the control of local contact 321 into position 3. After sequence switch 320 leaves position 2, the left-hand winding of relay 323 is disconnected at sequence switch contact 322 top, the right-hand holding winding is thereby short-circuited at contact 321, and relay 323 is deenergized. Relay 325 is energized in the circuit over the calling subscriber's line before sequence switch 320 reaches position 3. Relay 326 is now energized in a circuit over back contact of relay 323, and sequence switch contact 327 top, and a circuit is established for the energization of the thousands register 100 over contact 328 top of sequence switch 320, back contact and right-hand winding of the impulse limiting relay 329, sequence switch contact 330 top and front contacts of relays 326 and 325. The second winding of the differentially wound relay 329 receives current over the retardation coil 331. Relay 329 remains deenergized, whereas register 100 starts from position 0 and moves under the control of its local contact 101 into position 1. In position 3 of sequence switch 320 the primary winding of the dialing tone

coil 324 is connected over sequence switch contact 332 to an interrupter 333, and when the calling subscriber hears the sharp dialing tone, he winds up the dial on his station according to the first figure of the wanted number. As soon as the dial is given free it returns to its position of rest, producing interruptions in the line circuit, the last interruption being of longer duration than those preceding.

As soon as contact 101 on register 100 is closed, a short circuit around the right-hand winding of relay 329 is produced, and relay 329 becomes energized, disconnecting on its back contact the circuit for register 100 which maintains its energization over its contact 101 until the register reaches position 1 and contact 101 is opened. Relay 329 remains energized until the line circuit is opened at the dial and relay 325 is deenergized. Relay 329 in closing its back contact again prepares the circuit for the register 100. As soon as relay 325 is again energized, the register 100 receives current in the circuit described, and starts from position 1, causing the energization of relay 329 as soon as contact 101 of register 100 is closed.

Over the back contact of relay 329 relay 337 is also connected in parallel to register 100, which relay 337, when energized, maintains over its front contact the closure of the circuit for relay 329 independent from the contact of relay 325. The speed with which the register is moving is so selected that a register starts and completes its step in a shorter time than the total time of an opening and a closure on a fast dial. Through variations in the speed of the dials, the resistance of the line etc., the stepping relay which follows the impulses in the line may not stay on its front contact a sufficient time to ensure the starting of the register, whereas the quick energizing relay 337 makes it certain that the circuit once closed on the front contact of relay 325 is maintained until the register starts and moves from one position into the next. Relay 337 has also a further purpose in that relay 329, once energized, keeps its back contact opened until relay 337 is deenergized. If relay 337 is not provided and relay 325 opens its front contact before the register has reached its next position and has opened its contact 101, relay 329 would also become deenergized and both its windings in series would be brought over its back contact in parallel to the winding of register 100. Relay 329 would make an attempt to again leave its back contact which may then happen to be opened at the moment the front contact of relay 325 is again closed. Relay 329 would then become immediately energized over its left-hand winding, and the impulse will not go to the register, which will then fall short.

On the other hand, if relay 329 is deenergized and its back contact is closed at the moment contact 101 of the register is opened, the windings of relays 329 would be brought in parallel to the winding of register 100, delaying the deenergization of the register, and this would cause an overstepping of the register. Relay 337, which is maintained operated as long as contact 101 is closed, holds over its front contact the once energized left-hand winding of relay 329 under current, and hinders this relay from closing its back contact even if the stepping relay has left its front contact. This enables a safe operation of the register which can now be driven with a higher speed, and therefore makes it certain that the register would complete its step quicker than any dial which may lose its adjustment and increase its speed.

When on the last interruption at the dial of the line circuit, relay 325 remains deenergized for a comparatively longer time, it closes at its back contact a circuit for the energization of a slow-operating relay 334 for a time sufficient to energize this relay. The left-hand winding of relay 323 is then closed in a circuit over front contact of relay 334, and sequence switch 320 is again energized in the circuit over front contact of relay 323. Sequence switch 320 starts from position 3 and moves into position 6. The relation between the openings of the line circuit at the dial, the time relay 324 uses for its operation, and the time sequence switch 320 takes to move into the following position, is such that at all variations in speed and adjustment of the dials or voltage in the exchange, relay 334 does not operate during the short interruptions in the line circuit, but is energized and causes the start of the sequence switch on a long interruption at the dial, whereas the time this relay needs to energize, together with the time the sequence switch 320 takes to move into the following position is under all circumstances longer than the time relay 325 remains deenergized during the long interruption at a dial. In fact relay 325 is already energized over the subscriber line before sequence switch 320 reaches position 5.

When relay 323 is energized, it opens on its back contact the circuit for relay 326, which immediately opens the circuit for the energization of the registers, so that when relay 325 becomes again energized, the register circuit is maintained opened at front contact of relay 326 until sequence switch 320 reaches position 6. When relay 325 opens its back contact, relay 334 is deenergized, and opens the circuit of the left-hand winding of relay 323. The right-hand winding of this relay being short-circuited at contact 321, relay 323 is deenergized before sequence switch 320 reaches position 6.

When sequence switch 320 moves over position 4 an additional energization of register 100 is caused in a circuit over contact 330 bottom, and register 100 makes an additional step. The purpose of it is to enable the use in the directory of subscriber numbers beginning with the figure 1 so as to avoid numbers beginning with the figure 0.

When sequence switch 320 leaves position 5, the register 100 is disconnected at contact 328 top, and the hundreds register 110 is connected over sequence switch contact 328 bottom, whereby this contact is closed earlier than contact 327, so that the circuit for the register 110 is ready before relay 326 is energized. The first energization of register 110 takes place immediately the front contact of relay 326 is closed in a circuit including contact 105 of register 100. Register 110 starts from position 0, and in closing its contact 111, the right-hand winding of relay 329 is short-circuited and relay 329 opens its back contact, whereas the register completes its step under the control of its contact 111 and is arrested in position 1. Relay 337 is now connected in parallel to register 110, and maintains the energization of relay 329 during the time contact 111 is closed. When the dial is released a second time, register 110 is brought to a corresponding position, whereas sequence switch 320 is advanced from position 6 into position 10, in which the tens register 130 is now connected in the stepping circuit over sequence switch contact 335 top, and is set up according to the third series of impulses from the dial. Sequence switch 320 is then advanced from position 10 into position 13, in which the units register 140 is connected in the stepping circuit over sequence switch contact 335 bottom. When the dialing has been completed, sequence switch 320 is advanced from position 13 into position 16, in which the sequence switch remains waiting until the selectors have been set up under the control of the registers.

The capacity of the exchange is assumed to be two thousand. First group selectors and final selectors are therefore provided. The register 100 controls only the odd and even thousands, whereas the hundreds register 110 controls the selection of the corresponding level at the first group selector. The position of the registers determines the translation from the decimal number system of the wanted subscriber to the system of the switches, whereby register 100 determines the translation for the first group selector. Five levels on the first group selector are reserved for the odd thousand numbers and the other five levels for the even thousand. The setting up of the first group selector takes place during the time the subscriber continues the dialing, and since the trip spindle of the first group

selector has to take a position according to the position of the registers 100 and 110, the operation of the trip spindle of the first group selector is delayed until the first two impulse series are completed on the dial. This corresponds to sequence switch 320 leaving position 6. In position 7 of sequence switch 320 a circuit is closed for the energization of sequence switch 350 over its contact 352 top, contact 103 of register 110 and contact 338 top of sequence switch 320. Sequence switch 350 which controls the connection of the registers in succession for the control of the fundamental circuit of the selectors, starts from position 1, and under the control of its local contact 351, moves into position 3. In position 2 of sequence switch 350 is the right-hand winding of relay 359, energized in a circuit over back contact of stepping-out relay 355 and sequence switch contact 354 top. Relay 359 keeps open at its back contact the circuit for resetting of the registers.

Assuming that the number of the wanted line is 1253, when the dial is wound up and then released, eight short and one long opening are made in the line circuit. The register 100 having made its first step before the first interruption of the line, and not receiving any current after the long interruption, has therefore made nine steps under the control of the dial and one step under the control of contact 330 bottom. The register 100 is therefore again in its position 0. Register 110 has been energized eight times, under the control of the dial, and is therefore in position 8. When sequence switch 350 reaches position 3, the fundamental circuit is closed over contact 356 bottom of sequence switch 350, back contact of relay 357, winding of stepping out relay 355, common conductor 296, contact 286, bottom of sequence switch 280, contact 247 bottom of sequence switch 220 and winding of relay 222. Both relays 222 and 355 are energized. Relay 355 disconnects on its back contact the circuit for differential relay 359 which is now deenergized. Relay 222 causes the energization of sequence switch 220 in a circuit over back contact of relay 231, front contact of relay 222 and sequence switch contact 229 bottom. Sequence switch 220 starts from position 5 and moves into position 6 in which the trip spindle magnet 248 is energized in a circuit over sequence switch contact 249 top and front contact of relay 222. The trip spindle rotates and produces at its contact 250 top over sequence switch contact 223 bottom short-circuitings around the winding of relay 355. As soon as the back contact of relay 355 is closed, the register 110 is energized in a circuit over contact 112 of register 110, contact 361 bottom of sequence switch 350, back contact and left-hand winding of relay 359, back contact of relay 355

and sequence switch contact 354. Simultaneously with the energization of register 110, relay 362 is also energized and provides over its front contact a bridge to the contact of relay 355. Relay 362 in the circuit for the outgoing impulses has the same purpose as relay 337 in the circuit of the incoming impulses, and enables a safe operation of the registers. As soon as contact 111 is closed, the left-hand winding of relay 359 is short-circuited, and the right-hand differential winding of this relay causes the opening of its back contact. Register 110 starts from position 8 and moves into position 9, and as soon as its contact 111 is opened, relay 362 is deenergized. In the meantime, trip spindle contact 250 has been opened causing the stepping relay 355 to open its back contact whereby relay 359 is deenergized. On the following closure of contact 250, relay 355 is again deenergized, and register 110 energized, starts from position 9 and moves into position 0. On the following closure of contact 250, relay 357 is energized in a circuit over sequence switch contact 363 bottom, contact 104 of register 100, contact 114 of register 110, contact 361 bottom of sequence switch 350, back contact and left-hand winding of relay 349 and back contact of relay 355. Relay 357 opens the fundamental circuit. In parallel to the right-hand winding of relay 357 is also connected the sequence switch 350, which is energized, starts from position 3 and moves into position 4.

When contact 351 is closed and the left-hand winding of relay 359 is short-circuited, this relay is energized and maintains its energization over back contact of relay 355. After contact 250 of the trip spindle is also opened, relay 222 is deenergized, and sequence switch 220 is energized in a circuit over its contact 251 bottom and back contact of relay 222. Sequence switch 220 starts from position 6 and moves into position 7, in which the test relay 234 is connected at sequence switch contact 228 top with the test brush 252 of the first group selector. Relay 222 is now energized in a circuit over resistance 253, contact 246 top of sequence switch 220, contact 283 bottom of sequence switch 280, wire 293, back contact of relay 339 and contacts 240 top of sequence switch 320. The power magnet 241 of the group selector brush carriage is thereby energized in a circuit over contact 254 bottom of sequence switch 220, back contact of relay 232 and front contact of relay 222. The brush carriage rotates in the well-known manner with the brushes along the terminal row determined by the position of the trip spindle. In reaching the test terminal of a free final selector, relay 234 is energized in a circuit from ground, over contact 282 bottom of sequence switch 280, contact 227 bottom of

sequence switch 320, right-hand back contact of relay 224, right hand winding of relay 234, contact 228 top of sequence switch 220, test brush 252, contact 441 of sequence switch 450 individual to the final selector and resistance 442. In parallel to resistance 442 is also connected a high-resistance release relay 443. Relay 234 brings its low-resistance winding in parallel to its high-resistance winding, and makes the terminal of the final selector busy. As soon as contact 269 of the brush carriage is opened, and the shunt around relay 232 is removed, this relay is also energized, the power magnet 241 is disconnected at the back contact of relay 232, while a circuit is provided for the energization of sequence switch 220 over contact 229 top and front contact of relay 232. In parallel to the sequence switch is also connected, over its contact 235 top, the holding magnet 245 of the group selector, the brush carriage is arrested and sequence switch 220 starts from position 7 and moves over position 8 into position 9, in which the fundamental circuit is prepared at sequence switch contacts 247 top and 255 bottom to the final selector, pending the closure of the fundamental circuit at the register set.

Sequence switch 350 remains in position 4 until the tens and units registers have been set up under the control of the dial, and sequence switch 320 has moved into position 16, in which position sequence switch 350 is energized in a circuit over contact 363 top and contact 341 bottom of sequence switch 320. Sequence switch 350 starts from position 4 and moves into position 5, in which the fundamental circuit is closed at the register set over back contact of relay 357, and sequence switch contact 356 top and conductor 297, and at the final selector over the contacts 444 bottom and 445 top of sequence switch 450. Relay 452 at the final selector and relay 355 at the register set are energized; relay 359 is deenergized. A circuit is closed for the energization of sequence switch 450 over its contact 446 bottom and front contact of relay 452. Sequence switch 450 starts from position 1 and moves under the control of its local contact 451 into position 2, in which the trip spindle magnet 448 is energized in a circuit over sequence switch contact 447 bottom and front contact of relay 452. The trip spindle rotates and provides at its contact 455 top over sequence switch contact 449 bottom short-circuitings around relay 355 in the fundamental circuit.

When relay 355 is deenergized, register 130 is energized in a circuit over its contact 132, contact 367 top of sequence switch 350 and back contact of relay 359. Register 130 starts from position 5 and moves into position 6. After register 130 is restored to

position 0 under the control of relay 355, a circuit is established on the following de-energization of a relay 355 over contact 134 of register 130, and contact 352 top of sequence switch 350 for the energization of the sequence switch and the relay 357. The fundamental circuit is thereby opened, whereas sequence switch 350 starts from position 5 and moves into its position 7. After contact 351 is opened, relay 357 is deenergized, and the fundamental circuit is again closed at its back contact. When contact 455 of the trip spindle is opened, relay 452 is deenergized, and sequence switch 450 is energized in a circuit over its contact 453 top and back contact of relay 452. Sequence switch 450 starts from position 2 and moves into position 5. The duration of the opening of the fundamental circuit at back contact of relay 357 is so adjusted that contact 447 of sequence switch 450 is opened, before relay 452 can be energized a second time over the fundamental circuit, whereas the energization of this relay takes place before sequence switch 450 reaches position 5. The power magnet 461 of the brush carriage is now energized in a circuit over sequence switch contact 456 top and front contact of relay 452. The brush carriage rotates along the sixth terminal row; a series of short-circuitings of the stepping relay 355 in the fundamental circuit is again produced at contact 457 top of the brush carriage over sequence switch contact 449.

When the relay 355 is deenergized, a circuit is established for the energization of register 140 over contacts of relay 355 and 359, contacts 367 bottom of sequence switch 350 and contact 142 of units register 140. After register 140 reaches position 0, under the control of relay 355, a circuit is established for the energization of sequence switch 350 and relay 357 at the following de-energization of relay 355, over contact 143 of register 140, back contact of relay 374, contact 144 of register 140 and contact 352 top of sequence switch 350. The fundamental circuit is again opened and sequence switch 350 starts from position 7 and moves into position 18. When sequence switch 350 leaves position 9, the circuit in which relay 222 has been maintained energized during the progress of the selection is now opened at contact 368 top of sequence switch 350, causing the deenergization of relay 222 in the cord, whereby sequence switch 220 is energized in the circuit over its contact 251 bottom and back contact of relay 222. Sequence switch 220 starts from position 9. In position 10 of the sequence switch the fundamental circuit of the register set is disconnected at contacts 255 and 247 of sequence switch 220. Supervisory relay 262 and retardation coil 257 are connected over sequence switch contact 255 top and 256 top

to the final selector. When sequence switch 220 leaves position 9, stepping relay 325 is disconnected from the subscriber line at sequence switch contacts 242 and 243, and the subscriber line is again connected over these sequence switch contacts with relay 231 and retardation coil 237. In position 10 sequence switch 220 is energized in a circuit over its contact 258 bottom, and back contact of relay 262. Sequence switch 220 moves therefore over position 10 into position 11.

As soon as relay 325 at the register set is deenergized, sequence switch 320 is energized in a circuit over its contact 348 bottom. Sequence switch 320 starts from position 16 and moves into position 17. When sequence switch 350 reaches position 18, a circuit is established for its energization over contact 372 bottom of sequence switch 350, back contact of relay 326 and contact 352 bottom of sequence switch 350. The sequence switch starts from position 18, and moves into position 1, in which the left-hand winding of relay 323 is energized in a circuit over contact 354 bottom of sequence switch 350 and contact 322 bottom of sequence switch 320. Sequence switch 320 is now energized over front contact of relay 323, starts from position 17 and moves into position 1. The register set is free and can be taken for a new call.

After the fundamental circuit has been opened at the register set, the relay 452 is deenergized as soon as contact 457 top is opened, the power magnet 461 of the final selector is disconnected, whereas sequence switch 450 is energized in a circuit over contact 453 top and back contact of relay 452. In parallel to the sequence switch, the holding magnet is connected over its contact 458 bottom. The brush carriage is arrested, and sequence switch 450 starts from position 5 and moves into position 6. On subscriber line groups on which the final selector is arranged to search for a free line to private branch exchanges, the cutoff relays 488 on the single subscriber line and on a last line to a private exchange are provided with shunts 489. The final selector is provided with a special test relay 463 which can energize over the cutoff relay of a free private branch exchange line. Relay 463 is also energized over the test terminal of a single subscriber line, or of the last private branch exchange line, disregarding whether the line is free or busy; assuming the line free, test relay 463 is energized in a circuit over sequence switch contact 459 bottom, test terminal of the subscriber line 470 and cutoff relay 488, respective resistance 489. A circuit is thereby established for the energization of relay 462 over front contacts of relays 463 and 443, whereby sequence switch 450 is energized in a circuit over back

contact of relay 452, front contact of relay 462 and sequence switch contact 453 bottom. Sequence switch 450 moves over position 6 into position 10.

When the sequence switch of the final selector reaches position 8, the wanted line undergoes a final test and the right-hand high-resistance winding of the test relay 464 which can only energize on a free line, even if the cutoff relay is provided with a shunt, is connected in a circuit over the cutoff relay 488, terminal 470 and sequence switch contact 459 top. If the line is free, relay 464 brings over its front contact in parallel to its high resistance winding its left-hand low-resistance winding, together with the winding of relay 462. The terminal of the wanted line is made busy whereas relay 462 is energized. Sequence switch 450, in reaching position 10, is energized in the circuit over front contact of relay 462, and the sequence switch moves over positions 10 and 11, into position 12, in which an alternating ringing current is immediately sent to the station of the wanted line in a circuit over the sequence switch contacts 466 top and 467 bottom, including the ringing relay 460. Relay 452 is brought over sequence switch contact 468 bottom in connection with a common interrupter 469, which when closed, causes the energization of relay 452. The sequence switch 450 is energized in the circuit over the front contact of this relay and contact 446 bottom and moves into position 13. In position 13 relay 452 is connected over sequence switch contact 471 with a further common interrupter 472. The two interrupters 469 and 472 are continuously operated, and are arranged to close the circuit to ground at predetermined time intervals so that after the sequence switch 450 reaches position 12, it is brought after the lapse of a few seconds over positions 12 and 13, into position 14. The duration of time in which sequence switch 450 remains in positions 12 and 13 and an instantaneous ringing current is sent to the wanted station depends upon the moment the sequence switch reaches position 12, and varies slightly according to whether at this moment the interrupter 469 has just opened its contact or is near to close it. The contact of these interrupters is closed for a time sufficient to energize relay 452, and to cause the energization of sequence switch 450, but not sufficient to maintain its energization more than to move the sequence switch from one position. In this manner the sequence switch 450 is held in position 13 for at least a time which elapses between the closure of the interrupter 469 and the following closure of interrupter 472.

When sequence switch 450 reaches position 14, the direct connection of the ringing current is removed in opening sequence

switch contact 466, and the connection of the subscriber line with the ringing source of current is now maintained over sequence switch contact 473 bottom and the common interrupter 474, which in selected time intervals connects in succession the circuit either to the source of ringing current or to ground. During the time sequence switch 450 is in positions 12 to 14, the primary winding of tone coil 477 is connected over sequence switch contact 476 bottom to a common interrupter, whereas the secondary windings of coil 477 are connected in bridge to the line over sequence switch contacts 444 top and 445 bottom. The calling subscriber perceives thereby an indication that the ringing of the called party is proceeding. As soon as the receiver at the wanted station is lifted from the hook the ringing relay 460 is energized and causes over its front contact and sequence switch contact 446 top the energization of sequence switch 450 which starts from position 14 and moves into position 15 in which the ringing current supply is disconnected, and a through connection of the subscriber line is made over sequence switch contacts 473 top and 467 top to the transmitter current supply bridge at the group selector. Relay 262 is thereby energized. Sequence switch 220 is energized in a circuit over the contact 229 top and front contact of relay 262. Sequence switch 220 starts from position 11 and moves into position 12. If the number of the wanted subscriber number begins with the figure 2, and the wanted number is for example 2253, the thousands register 100 receives eight impulses from the dial and one impulse over contact 330 bottom of sequence switch 320. The register 100 is therefore in position 9. When the fundamental circuit is closed over relay 222 of the first group selector, the resetting of the hundreds register 110 begins in the manner as has been described, and when register 110 reaches position 0 the following deenergization of relay 355 provides a circuit for the energization of register 100 over contact 114 of register 110 and contact 102 of register 100. This causes register 100 to move from position 9 into position 0, so that sequence switch 350 and the relay 357 are energized on the next deenergization of relay 355. The trip spindle of the first group selector has therefore made an additional step, and is arrested in its fourth instead of its third position, as has been previously described. The brush carriage of the first group selector searches now in an even level for a free final selector.

If the second figure of the wanted number is odd, for example, number 1353, register 110 receives from the dial seven impulses and is arrested in its position 7. When sequence switch 350 moves over its position 1½, relays 373 and 374 are energized in a circuit over contact 365 of sequence switch 350, and contact 116 of register 110, whereby relay 373 provides a locking circuit over its front contact and sequence switch contact 372 top. After the units register 140 has been set up, the energization of relays 373 and 374 is maintained over contact 146 of register 140 and contact 354 of sequence switch 350. When sequence switch 350 passes over position 2, register 110 is energized in a circuit over contact 112, contact 361 top of sequence switch 350 and contact 116 of register 110. Register 110 makes an additional step and takes the same position as if the next lower even figure has been dialed. The trip spindle of the group selector takes therefore the same position, disregarding whether the second figure of the wanted number was even or odd, whereas relay 374 controls the translation of the units on the final selector, causing the advance of the brush carriage to the second half of the terminal row. When the brush carriage of the final selector is rotating and relay 355 controls the units register 140, the circuit of this register is maintained in position 0 over front contact of relay 374 and contact 143 of register 140. Register 140 passes therefore over 0 position and starts a second rotation. When moving between position 0 and position 1, the holding circuit of relay 373 and 374 is now opened at contact 146 of register 140 and relays 373 and 374 are deenergized. When the units register 140 completes its second rotation and reaches position 0, the circuit is extended over contact 143, back contact of relay 374 and contact 144 of register 140 to the sequence switch 350. The brush carriage of the final selector is therefore arrested at the second half of its terminal arc in a position corresponding to the position of the units register.

When, after a successful conversation, the calling subscriber restores his receiver on the hook relay 231 is deenergized, and sequence switch 220 is energized in a circuit over sequence switch contact 251 bottom, and back contacts of relays 222 and 231. Sequence switch 220 starts from position 12 and moves over position 13 into position 17. When the sequence switch 220 moves over position 14 to 16, the metering battery 259 is connected over sequence switch contact 236 bottom and left-hand back contact of relay 224 to terminal 238, whereby the meter 208 of the calling subscriber line is operated. In position 17 of sequence switch 220 the power magnet 241 of the brush carriage of the first group selector is again connected in the circuit over sequence switch contact 254 bottom, back contact of relay 232, contact 227 top of sequence switch 220 and contact 282 bottom of sequence switch 280. The brush carriage rotates until its home contact

269 is reached, whereby relay 232 is energized in a circuit over contact 269 and sequence switch contact 226 top. The power magnet 241 is disconnected, whereas sequence switch 220 is energized in the circuit over the front contact of relay 232. In parallel to the sequence switch 220 is also connected over its contact 233 top the holding magnet 245. The brush carriage is arrested whereas sequence switch 220 starts from position 17 and moves into position 18.

After sequence switch 220 leaves position 12 the brushes of the group selector are disconnected at the sequence switch contacts 228, 256 and 255, relay 443 at the final selector is deenergized and sequence switch 450 is energized in a circuit over contact 458 top and back contact of relay 443. Sequence switch 450 starts from position 15 and moves into position 17. Notwithstanding the deenergization of relay 443, the circuit containing test relays 462 and 464 is maintained closed over sequence switch contact 478 top and the called line is maintained busy. In position 17 of sequence switch 450 relay 452 is brought over sequence switch contact 466 bottom, in connection with the called line, and if the called subscriber has not restored his receiver, relay 452 is energized over the subscriber line in a circuit including sequence switch contacts 467 and 445. Sequence switch 450 is held in position 17 and lamp 481 is connected in a circuit over sequence switch contact 446 top and front contact of relay 452, displaying a guarding signal. When the called subscriber has also restored his receiver, relay 452 is deenergized and sequence switch 450 is energized in the circuit over contact 453 and back contact of relay 452. Sequence switch 450 starts from position 17 and moves into position 18 in which the power magnet 461 of the brush carriage is energized in a circuit over sequence switch contact 456 bottom, back contacts of relays 462 and 452. The brush carriage rotates until its home contact 457 bottom is closed, whereby relay 452 is energized in a circuit over contact 457 bottom and sequence switch contact 468 top. The power magnet 461 is disconnected whereas sequence switch 450 is energized in the circuit over its contact 446 and front contact of relay 452. In parallel to sequence switch 450 is the holding magnet connected over its contact 458; the brush carriage is arrested, whereas sequence switch 450 starts from position 18 and moves into position 1.

After the release of a connection, sequence switch 220 of the cord remains in position 18 until the second cord of the pair of cords is engaged in a call. This arrangement is best shown in Figure 7 in which relay 272 corresponds to relay 262 in the cord of Fig. 2; sequence switch 270 corresponds to sequence switch 280 of Fig. 2, and contacts

274 and 276 correspond to sequence switch contacts 244 and 256 of sequence switch 220, while contacts 278 and 279 correspond to sequence switch contacts 288 and 289 of sequence switch 280, and wires 271 and 275 correspond to wires 291 and 292. Assuming the second cord to be engaged in a call, sequence switch 220 provides in position 18 a circuit for the energization of sequence switch 280 over contact 244 bottom of sequence switch 220, wire 291, and a contact on the second cord corresponding to sequence switch contact 289. Sequence switch 280 rotates and moves into position 10. In passing position 9½, a circuit is closed for the energization of relay 262 over contact 256 bottom of sequence switch 220 and contact 288 top of sequence switch 280. Sequence switch 220 is thereby energized over front contact of relay 262 and sequence switch contact 229. Sequence switch 220 starts from position 18 and moves into position 1 whereby contact 244 is opened before sequence switch 280 reaches position 10.

If the called subscriber is the first to restore his receiver on the hook, relay 262 in the cord is deenergized and sequence switch 220 is energized in a circuit over back contact of relay 262 and sequence switch contact 258 top. Sequence switch 220 starts from position 12 and moves into position 13. The circuit over the brushes of the first group selector is thereby disconnected at sequence switch contacts 228, 256 and 255. The final selector is released, while the sequence switch of the cord remains in position 13 and the calling line is held busy until the calling subscriber restores his receiver and relay 231 is deenergized. Sequence switch 220 is then energized over back contacts of relays 231 and 222.

If the wanted line has been found busy and the test relays 464 and 462 have not been energized, when sequence switch 450 of the final selector moves over position 8, the sequence switch 450 is arrested in position 10, in which the primary winding of the busy tone coil 477 is connected over sequence switch contact 476 to a busy tone interrupter. The secondary winding of the busy tone coil 477 is thereby brought in bridge to the line, and the calling subscriber receives a busy tone. When the subscriber restores his receiver and relay 231 is deenergized, a circuit is established for the energization of the left-hand winding of metering hindering relay 224 including back contacts of relays 231, and 222, contact 251 top of sequence switch 220 in position 11. Relay 224 disconnects at its left-hand back contact the circuit for relays 235, 213 and 207, while over a holding circuit is provided the left-hand front contact of relay 224 for its left-hand winding. Over the right-hand front contact of relay

224 and its right-hand low-resistance winding, a circuit is established for the energization of sequence switch 220, including contact 227 bottom of sequence switch 220, and  
 5 contact 282 bottom of sequence switch 280. Sequence switch 220 starts from position 11 and moves over positions 12 and 13 into position 17. The purpose of resistance 236 in the circuit of the local contact 265 of  
 10 sequence switch 220 is to hinder the deenergization of the right-hand winding of relay 224. After the disconnection of the group selector, relay 443 is deenergized and sequence switch 450 is energized over  
 15 back contact of relay 443, starts from position 10 and moves into position 11, in which the power magnet 461 is energized in a circuit over sequence switch contact 456 and back contacts of relays 462 and 452.  
 20 The brushes are restored to their position of rest, whereby after contact 457 bottom is closed, relay 452 is energized, causing the energization of sequence switch 450 over front contact of relay 452. Sequence switch  
 25 450 starts from position 11 and is maintained energized in positions 12 to 15 over back contact of relay 443, while in position 17 sequence switch 450 is energized over back contact of relay 452 and moves into  
 30 position 18, where relay 452 is again energized over contact 457, so that sequence switch 450 is energized over front contact of relay 452 and moves into position 1.

35 Since sequence switch 220 is held in position 11, whether the wanted line is busy or a ringing current is sent to the wanted station, relay 224 is energized if the calling subscriber gives up the connection before the called subscriber has answered. The  
 40 release proceeds therefore without metering if the sequence switch of the final selector is in its ringing position and the called subscriber does not answer.

45 If the called number belongs to a private branch exchange, relay 463 tests in position 6 of sequence switch 450 the terminal to which the brushes of the final selector have been brought under the control of the register set. Assuming the first private  
 50 branch exchange line busy, relay 463 remains deenergized. Power magnet 461 is energized in a circuit over sequence switch contact 456 bottom and back contact of relay 462. The brush carriage rotates and  
 55 and a free line is searched for in reaching which relay 463 is energized. During the time the brushes move from one terminal to another, relay 462 is short-circuited over sequence switch contact 449 top of sequence  
 60 switch and contact 457 top of the brush carriage. As soon as the brushes are centered at the terminals of a free line and contact 457 is opened, relay 462 is energized, and sequence switch 450 is advanced from  
 65 position 6. If all lines to the private branch

exchange are busy, relay 463 is energized on the terminal of the last line, and through resistance 489. On the repeated test in position 8 of sequence switch 450, relay  
 70 464 remains deenergized. Sequence switch 450 is arrested in position 10 and a busy tone is given to the called station. Through the repeated test on a final selector for private branch exchange lines, it is enabled to connect the relays 463 and 464 in succe-  
 75 sion in the test circuit instead of in parallel or in series, so that sufficient energy is secured in the circuit for the energization of these relays.

A connection can be immediately released  
 80 at any stage of the progress of the selection. In the first instance, a premature release can take place if two second line finders happen to stay on the same terminals, and relays  
 85 234 of both cords may become simultaneously energized whereby the relays 232 may also energize, and the sequence switch 220 of both cords may start from position 1. When sequence switch 220 passes between  
 90 positions 1 and 3, the circuit for the high-resistance winding of relay 234 is opened at contact 227 bottom. Relay 234 is not able to maintain its energization over its left-hand winding if the current over resistance 217 is divided in two branches. Relay  
 95 234 is thereby deenergized, causing the deenergization of relay 232, whereby the left-hand winding of relay 224 is energized in a circuit over sequence switch contact 254 top, back contact of relay 232, sequence  
 100 switch contact 229 bottom and contact 263. Relay 224 maintains its energization over its left-hand front contact and left-hand winding, and hinders the energization of relay 235. Sequence switch 220 is arrested in  
 105 position 4 in which sequence switch 280 is energized in a circuit, as has been described, and rotates until arrested either on the terminals of a free register set, in which relays 234 and 232 are energized, or in po-  
 110 sition 10, whereby when passing position 9½ a circuit is provided for the energization of sequence switch 220 over contact 289 of sequence switch 280 and right-hand front contact of relay 224. Sequence switch 220  
 115 starts from position 4 and completes then its cycle of operation without disturbing the calling line, or an engaged register set. When sequence switch 220 reaches position 18, sequence switch 280 is energized over  
 120 contact 288 bottom and contact 244 of sequence switch 220. Sequence switch 280 moves into its position 1.

When a release is started during the time the searching sequence switch 280 is rotat-  
 125 ing, not finding a free register, relay 231 is deenergized, and relay 224 is energized in a circuit over back contacts of relays 231 and 222 and contact 251 of sequence switch 220 in position 4. The calling line is immedi-  
 130

ately given free, and when sequence switch 280 reaches position 9½, sequence switch 220 is energized in the circuit over contact 289 of sequence switch 280. The release is completed as has been described. When a release is started, after the cord has been brought in connection with a free register set, relay 325 remains deenergized for a longer time than on a last opening at the dial. If relay 325 is not energized when sequence switch 320 being started through the energization of relay 323, reaches position 3, relay 334 is energized, sequence switch 320 moves over position 3 and, in passing position 5, relay 325 closes a circuit for the energization of relay 339 over contact 348 top of sequence switch 320 and back contact of relay 325. Relay 222 in the cord is energized in a circuit over front contact of relay 339, contact 376 top of sequence switch 350, wire 296, contact 286 of sequence switch 280 and contact 247 of sequence switch 220, so that sequence switch 220 is started from position 5 and moves into position 6. In the meantime sequence switch 350 has been started from position 1 as soon as sequence switch 320 has reached position 7, and the circuit for relay 222 is opened at contact 376 of sequence switch 350. Relay 222 is deenergized and sequence switch 220 moves into position 7 in which relay 222 cannot become energized since the back contact of relay 339 is opened, so that sequence switch 220 moves over position 7 into position 8, in which the left-hand winding of relay 224 is energized in a circuit over sequence switch contact 251 top. In position 8 of sequence switch 220, relay 232 is energized in the circuit over the home contact 269 of the brush carriage, and contact 226 of sequence switch 220. The energization of sequence switch 220 is maintained over the front contact of relay 232 and sequence switch contact 227. Sequence switch 220 moves over position 8. In positions 9 to 13, the sequence switch 220 is maintained energized over right-hand front contact of relay 224 and contact 227, and in position 17 over front contact of relay 232.

When the release begins at the time the brush carriage of the group selector is rotating, searching for a free trunk line to a final selector, the energization of relay 339 causes the deenergization of relay 222, sequence switch 220 starts from position 7 and moves into position 8 in which relay 224 is energized. The power magnet 241 remains energized, whereas the left-hand winding of test relay 234 is disconnected at the right-hand back contact of relay 224. The brush carriage continues to rotate without testing the terminals of the trunk lines, and after the brushes reach their position of rest, relay 232 is energized in the circuit over home contact 269, and the sequence

switch is advanced over positions 8 to 17, as has been described. Should a release begin at the time sequence switch 220 is in position 9, and the fundamental circuit is extended to the following selector, the energization of relay 359 causes the deenergization of relay 222. Sequence switch 220 is energized in position 9 over back contact of relay 222. In position 10, the energization of sequence switch 220 is maintained over back contact of relay 262. Relay 224 is energized as soon as the sequence switch reaches its position 11.

When the release is started before the dialing is completed, relay 339 is energized in one of the positions 5, 9 or 12, of sequence switch 320, whereas when the connection is given up at the calling subscriber station after the wanted number has been dialed, but before the selection is completed, sequence switch 320 is energized in position 16 over contact 348 bottom and back contact of relay 325. In position 17, relay 339 is energized in the circuit over sequence switch contact 348 top and back contact of relay 325, so that relay 222 in the cord is deenergized. At contact 342 top of sequence switch 320, the back contact of relay 359 is connected to ground and the circuit is established for the resetting of the registers, should they not be in their position 0.

When a premature release is made at a stage in which sequence switch 220 is in position 7, and relay 224 is then energized, sequence switch 220 remains in position 8 until the brush carriage is restored to its position of rest. During all the time the brush carriage is restored, relay 222 remains connected over sequence switch contact 246 top to wire 293. It is therefore desirable that the register set shall not be given free and shall not be taken for a new call until contact 246 of the cord which has been released is opened. If the sequence switch 350, started from position 7 after the registers have been restored, reaches position 18 before contact 246 of sequence switch 220 is opened, a circuit is established for the energization of relay 326 over back contact of relay 323, contact 368 bottom of sequence switch 350, wire 293, contact 246 top of sequence switch 220 and winding of relay 222. Sequence switch 350 is held in position 18 until contact 246 is opened, and relay 326 is deenergized.

When the release is started after the group selector has obtained connection with the terminals of a free final selector, and sequence switch 450 has left position 1 through the closure of the fundamental circuit at the register set, relay 452 is deenergized as soon as the relay 357 opens the fundamental circuit and enables sequence switch 450 to pass over positions 2 and 5 and to disconnect resistance 442 before the fun-

damental circuit can be again closed, should the terminal of the final selector immediately be taken by another cord.

The fundamental circuit may be opened at the moment the brush carriage of a final selector has started from its position of rest, and contact 457 bottom has not been opened, whereby the brushes may be arrested in the line with the trip spindle. Sequence switch 450 would thereby pass over positions 6 and 11, and when in position 12 the trip spindle is restored in the well-known manner to its position of rest in energizing magnet 448 in a circuit over sequence switch contact 447 top and trip spindle contact 455 bottom, the latches of several brush sets would be released. The circuit of the final selector is therefore so arranged that whenever its sequence switch 450 passes over positions 8 to 9, a check is made whether the home contact is opened. If this is not the case, relay 452 is energized in the circuit over contact 457 bottom and the power magnet 461 is energized in the circuit over contact 456 top of sequence switch 450 and front contact of relay 452. The brush carriage is moved out until contact 457 is opened, so that sequence switch 450 is arrested in position 11 and the brush carriage is restored to its position of rest. In all premature releases the operation of the meter 208 on the calling line is hindered through the disconnection of the metering battery 259 at the left-hand back contact of relay 224.

When the dial on the subscriber station is erroneously set up to a higher number than the capacity of the exchange, and the first figure dialed is different from figure 1 or 2, the register 100 in the exchange takes a position different from position 9 or 0. Should the subscriber notice the error and restore his receiver for a short while, the premature release will take place as has been described, and after the receiver is again removed, the calling line will obtain a connection with another cord. If the subscriber does not notice his mistake, he obtains a connection in the exchange over a special line to the supervisory operator who calls the attention of the subscriber to the error made. If register 100 takes a position different from position 9 or 0, sequence switch 350 cannot start from its position 1 after sequence switch 320 reaches its position 7, since the circuit for the energization of sequence switch 350 is maintained opened at contact 103 of register 100. Also, registers 110, 130 and 140 are hindered from receiving impulses from the stepping relay 325 through the opening of contact 105 on register 100, and these registers remain in their position 0, whereas after each series of impulses from the dial, relay 334 is energized and the sequence switch 320 is advanced to its next po-

sition. After the subscriber completes the dialing, and sequence switch 320 moves into position 16, sequence switch 350 is energized in a circuit over contact 363 and contact 341 bottom of sequence switch 320. Sequence switch 350 starts from position 1 and moves into position 3. The fundamental circuit is then closed to the group selector, and its trip spindle when rotating controls the resetting of register 100 to a level corresponding to the first figure dialed. Since the following registers are in their position 0, a number is selected consisting of three figures of which the first is the same as the first figure dialed and the remaining figures are zero. The lines 300, 400 and so on are reserved in the directory, and are connected to the desk of the supervisory operator, and the operator when communicating with the subscriber, knows which first figure the subscriber has erroneously dialed. One of these special trunk lines 502, 503, 504 leading to the supervisory operator's position is shown terminating in the contact bank of the final selector in Fig. 5. When the connection is extended to the operator's position relay 505 operates in a circuit including relay 464. Relay 505 closes a circuit for lamp 506, notifying the operator that a call is waiting her attention.

Each register set is provided with a key 301 at the complaint operator's position, and a subscriber who is unable to control the registers due to a disturbed dial etc., is able to obtain a connection with the complaint desk in removing the receiver from the hook and waiting some time after he receives the dialing tone. A common timing arrangement for delayed signals is provided in the exchange, as shown in Fig. 6. When a register is attached to a cord, a guarding lamp 344 lights in the exchange in a circuit over contact 345 of sequence switch 320. When sequence switch 320 passes position 2, a circuit is temporarily established over contact 327 bottom of sequence switch 320, the left-hand winding of relay 392 and back contact of relay 393. Relays 392 and 393 are common for several register sets. One of the windings of relay 395 is thereby energized over sequence switch contact 345 top and guarding lamp 344. Relay 392 when energized, provides according to the position of sequence switch 390, a circuit either over its left or its right-hand front contact, its right-hand winding, right-hand back contact and winding of relay 393, and left-hand front contact of relay 395. Relay 393 is thereby energized, disconnecting on its left-hand back contact the operative winding of relay 392 and providing over its right-hand front contact a locking circuit for its winding. Over the left-hand front contact of relay 393 the right-hand winding of relay 392 is maintained energized.

Relay 394, common for a large number of register sets, is connected in a circuit over right-hand front contact of relay 395 to a common interrupter 399. The interrupter 399 provides at given time intervals the closure of the circuit for relay 394 which is therefore energized each time the interrupter 399 is closed, and a sequence switch 320 of a register set is in position 3. Relay 394 provides a circuit for the energization of sequence switch 390 over back contact and right-hand winding of relay 398 and front contact of relay 394. The left-hand winding of relay 398 is thereby connected in parallel to sequence switch 390, and the differentially wound windings of relay 398 remain deenergized. Sequence switch 390 is energized, starts from the position in which it happens to stay, and in closing of its local contact 391, provides a shunt around the right-hand winding of relay 398, the left-hand winding of which is then energized. The sequence switch 390 moves in the next position, whereas relay 398 remains energized as long as relay 394 is energized over the interrupter 399. Since sequence switch 390 is arrested in a number of positions, it completes slowly a cycle of operation in a predetermined length of time, while interrupter 399 which is driven from the common power shaft can be comparatively quicker. On contacts 396 and 397 of sequence switch 390 the energization of relay 392 is maintained until sequence switch 390 starts from position 15 and moves into position 1. When relay 392 is deenergized, a circuit is prepared for the complaint lamp 308 individual to the register set over contact 340 of sequence switch 320, and back contact of relay 392. The closing of this circuit is delayed until sequence switch 390 again reaches position 11 and contact 397 is again closed. The lighting of the lamp 308 before the complaint operator is therefore delayed at least the time necessary for sequence switch 390 to move from position 15 into position 11. If sequence switch 320 passes over position 2 and relay 392 is energized when sequence switch 390 is in a position earlier than position 15, the lighting of the lamp 308 is still further delayed. When sequence switch 320 in a regular connection leaves position 3, relay 395 is deenergized and the holding circuit for relay 393 is opened. Lamp 308 is now displayed before the complaint operator.

The operator in noticing lamp 308, depresses key 301, whereby the stepping relay 325 of the register set is brought in connection with a dial 302, whereas in bridge to the calling line are now connected the windings of relay 303. The contacts on keys 301 are so arranged that first the dial is connected, then relay 303 is brought in parallel to relay 325, and after that the two circuits

are separated. Relay 303 brings over its front contacts the wires 304 of the operator's telephone into connection with the calling line. The operator communicates with the subscriber, whereas the register is maintained undisturbed. The lamp 308 also serves to indicate the presence of a short-circuit across the subscriber's line. If this is the case she can either directly notify the troubleman, or in operating her dial once, cause the advance of switch 320 to a later position in which a time alarm signal 500 is displayed before the troubleman by means of a circuit through contact 338 bottom and relay 501. If the complaint operator finds that the subscriber is not able to set up the register, and having ascertained that the subscriber has not dialed after he removed the receiver the last time, she sets up the register set according to the wanted number from her dial and restores the key 301. The registers then take positions according to the number dialed and control the setting up of the switches for the connection, whereby relay 325 is maintained energized over the subscriber line after key 301 is restored. When the selection is completed, the register set is released, and the sequence switch of the cord is advanced into the position of a through connection which remains under the control of the calling subscriber.

As illustrating the construction and operation of a switch mechanism suitable for use in systems of this character, reference is made to the patent to F. R. McBerty No. 1,097,868, granted May 26, 1914.

What it claimed is:

1. In a telephone system, a line, selective switches for extending said line, a register controlling mechanism for controlling said switches, means for associating the controlling mechanism with said line, means operated over the line to set said mechanism, an operator's position, a signal thereat, and means operated following the association of said mechanism with the line if said mechanism fails to undergo its setting operation for rendering said signal effective.

2. In a telephone system, a line, selective switches for extending said line, a register controlling mechanism for controlling the movement of said switches, means for associating the controlling mechanism with said line, means responsive to impulses sent over said line for setting the controlling mechanism, an operator's position, a signal thereat, and means operated following the association of said mechanism with the line if said mechanism fails to undergo its setting operation for rendering said signal effective.

3. In a telephone system, a line, selective switches for extending said line, a common register controlling mechanism for controlling the movement of said switches, means for associating the controlling mechanism

with said line, means for associating said mechanism with one of said switches, means operated over said line for setting the controlling mechanism, an operator's position, a signal thereat, means operated in response to the association of said mechanism with the line for rendering said signal effective, and means at the operator's position for setting said controlling mechanism.

4. In a telephone system, a subscriber's line, a selective switch for extending said line, a register controlling mechanism for controlling the movement of said switch, means at the subscriber's substation for sending impulses over the line, means responsive to such impulses to set said mechanism, an operator's position, a signal thereat, means operated by the controlling mechanism for rendering said signal effective, and impulse sending means at the operator's position for setting said mechanism.

5. In a telephone system, a subscriber's line, selective switches for extending said line, a controlling mechanism comprising a plurality of registers for controlling the movement of said switches, means controlled over the subscriber's line for variably setting said registers in accordance with desired designations, an operator's position, a signal thereat, means operated by the controlling mechanism for rendering said signal effective, and means at the operator's position for variably setting said registers in accordance with desired designations.

6. In a telephone system, a line, selective switches for extending said line, a register controlling mechanism for controlling the movement of said switches, means for associating the controlling mechanism with said line, means for variably setting said controlling mechanism, an operator's position, a signal thereat, and means operated by said mechanism at the end of a predetermined interval following the association of said mechanism with the line for rendering said signal effective.

7. In a telephone system, a line, selective switches for extending said line, a common register controlling mechanism for controlling the movement of said switches, means operated upon the initiation of a call for associating the controlling mechanism with said line and with one of said switches, means for variably setting said controlling mechanism, an operator's position, a signal thereat, and means operated at the end of a predetermined interval following the association of said mechanism with the line for rendering said signal effective.

8. In a telephone system, a subscriber's line, a selective switch for extending said line, a register controlling mechanism for controlling the movement of said switch, means for associating the controlling mechanism

with said line, means operated over said line for variably setting said mechanism, an operator's position, a signal thereat, means operated by said mechanism at the end of a predetermined interval following the association of said mechanism with the subscriber's line for rendering said signal effective, and means controlled by the operator for variably setting said mechanism.

9. In a telephone system, a subscriber's line, selective switches for extending said line, a register controlling mechanism for controlling the movement of said switches, means for associating the controlling mechanism with said line, means operated over said line for variably setting said mechanism, an operator's position, a signal thereat, means operated by said mechanism at the end of a predetermined interval following the association of said mechanism with the subscriber's line for rendering said signal effective, means for establishing a talking connection between said line and the operator's position, and means controlled by the operator for variably setting said mechanism.

10. In a telephone system, a subscriber's line, selective switches for extending said line, a register controlling mechanism for controlling the movement of said switches, means for associating the controlling mechanism with the subscriber's line, means for variably setting said mechanism, an operator's position, a signal thereat, a timing device rendered effective by said mechanism in response to the association of said mechanism with the subscriber's line, and means operated by said device after the lapse of a time interval for rendering said signal effective.

11. In a telephone system, an exchange having a plurality of lines, each line having an individual designation, selective switches, a register controlling mechanism, means for variably setting said mechanism in accordance with said designations, means controlled by said mechanism for operating the selective switches to extend a calling line to a desired line in the exchange, an operator's position, and means for extending the calling line to said operator's position when said mechanism is set in accordance with a designation other than those of the lines of said exchange.

12. In a telephone system, a calling line, selective switches, a controlling mechanism comprising a plurality of registers, means for sending series of impulses over the calling line, each of said series being effective to set a corresponding one of said registers, means controlled by said registers for operating the selective switches to extend the calling line, an operator's position, and means operated in response to certain series of impulses for rendering the following se-

ries ineffective to set the corresponding registers, said registers being effective in such a case to control the selective switches to extend the calling line to the operator's position.

13. In a telephone system, an exchange having a plurality of lines, each line having an individual designation, selective switches, a register controlling mechanism, means for variably setting said mechanism in accordance with said designations, means controlled by said mechanism for operating the selective switches to extend a calling line to a desired line in the exchange, an operator's position, a signal thereat, and means for operating said signal when said mechanism is set in accordance with a designation other than those of the lines of said exchange.

14. In a telephone system, an incoming line, a plurality of outgoing lines, means including an automatic switch for extending said incoming line to a wanted outgoing line, a sender selectively adjusted by impulses over said incoming line to control the setting of said automatic switch, means for connecting said sender to said incoming line, an operator's position, and means for signaling said position when no impulses have been transmitted to said sender after its seizure.

15. In a telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for extending said incoming line to a desired outgoing line, subscriber

controlled means including a register sender and operator controlled means for causing said automatic switch to extend said incoming line to a desired outgoing line, said subscriber controlled means being normally effective to control the operation, a signal for indicating the necessity of using the operator controlled means, and discriminating means for controlling said signal.

16. In a telephone system, a plurality of telephone lines, certain of said lines being provided with impulse transmitting devices, a register sender arranged to be variably controlled over a telephone line in response to the operation of said impulse transmitting device, means including automatic switches for interconnecting any one of said lines with any of the other lines, said automatic switches being controlled in accordance with the setting of said register sender, an operator controlled transmitting device for causing said automatic switches to interconnect a telephone line to any of the other lines, and a signal for indicating that the operator's transmitting device must be used in completing a connection, and means for disabling said signal.

In witness whereof I hereunto subscribe my name this 5th day of February, A. D. 1919.

LIPA POLINKOWSKY.

In witness whereof I hereunto subscribe my name this 13th day of May, A. D., 1919.

GERALD DEAKIN.