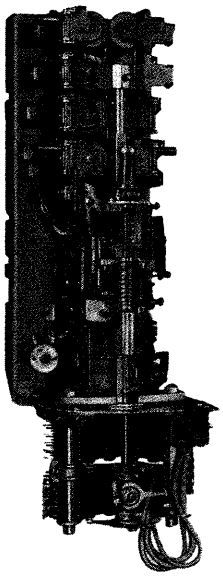
THE SELECTOR



Bulletin 945-808

AUTOMATIC ELECTRIC TRAINING SERIES

AUTOMATIC ELECTRIC
GENERAL SYSTEM
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

CONTENTS

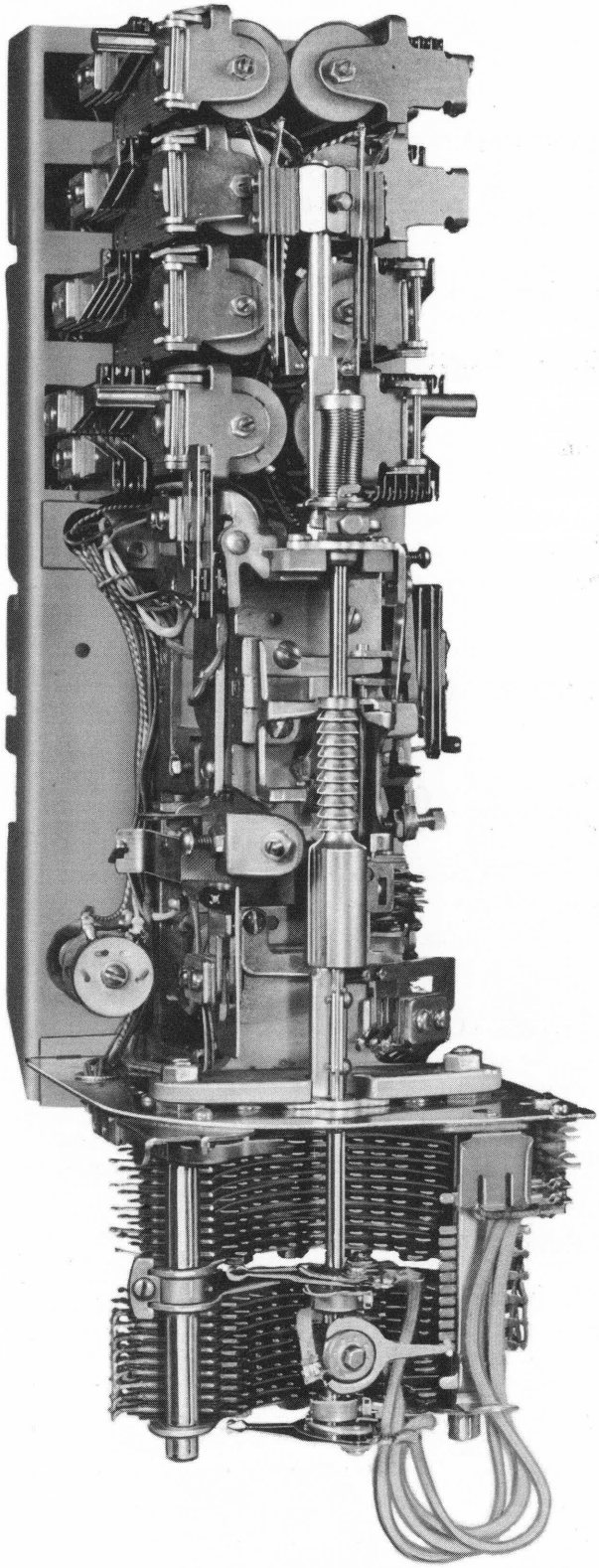


Figure 1. Typical digit-absorbing selector.

Illustrated is an absence-of-ground searching selector, the circuit of which is similar to that shown on figure 5.

THE SELECTOR

1. GENERAL

When the total number of terminals to be served by a Strowger Automatic exchange is greater than the terminal capacity of the connectors used, one or more selectors must be employed in the switch train by which each connection is set up.

Assuming that 100-terminal connectors are used, a single rank of selectors is required in a 1000-terminal system. The first digit dialed operates a selector to select the desired hundred-group of connectors. The selection of the particular terminal in the hundred-group of connectors (tens and units selections) is the function of the connector switch.

In a 10,000-terminal system, two ranks of selectors are required: the first is operated by the first digit dialed, and selects the thousand-group of trunks* which terminates in the second rank of selectors; the second rank of selectors is operated by the second digit, and selects the desired hundred-group of connectors in the thousand-group previously selected.

Similarly, in a 100,000-terminal system, the first selector in the train will select the desired office unit (comprising 10,000 terminals ultimate); the second selector, the desired thousand-group in that office unit; and the third selector, the desired hundred-group in the thousand-group previously selected.

The selector is a numerical type of group-selecting, trunk-hunting switch which requires but one digit for its operation. It is a two-motion switch employing a shaft which first is raised vertically and then is rotated horizontally. The pulses created by the dial control the vertical motion, which is the movement that selects the desired trunk group. The rotary motion is automatic, and is the trunk-hunting movement of the selector.

*** American Institute of Electrical Engineers "American Standard Definitions of Electrical Terms" section 65.18.117 defines a trunk as "a telephone line or channel between two central offices or switching devices, which is used in providing telephone connections between subscribers generally."**

2. MECHANICAL ARRANGEMENT

A typical selector is shown in figure 1. The selector comprises a group of control relays mounted on a base on which are mounted also a frame supporting a shaft and a ratchet mechanism for raising and rotating the shaft. Affixed to the lower portion of the shaft are two sets of wipers, termed the "line" and "control" wipers. Mounted within the switch frame are the vertical and rotary stepping magnets, and the magnet which releases the ratchet mechanism and permits the shaft to return to normal when the connection is released. The number of vertical steps the wipers rise depends upon the number of pulses in the digit dialed, and the number of rotary steps the wipers take to the right depends upon the number of "busy" trunks encountered in the selected bank level.

The pulses for vertical stepping energize the vertical magnet, causing the vertical armature to operate and raise the shaft a corresponding number of steps, by means of a pawl affixed to the end of the armature engaging a toothed hub known as the "vertical hub." As soon as vertical stepping is completed, the rotary magnet automatically rotates the shaft until an idle trunk is found in the selected bank level. The automatic stepping motion of the rotary armature is transmitted to the shaft by means of the rotary pawl engaging a toothed hub known as the "rotary hub."

These stepping motions cause the wipers to engage contacts of a semicylindrical bank secured to the bottom of the selector. Referring to figure 1, it will be observed that the bank contacts are arranged in two groups; the upper of the two is termed the "control" bank, and the lower, the "line" bank. A latch with two detents, termed the "double dog," holds the shaft and wipers in the position to which they have been stepped by the vertical and rotary movements.

The shaft is released by the release magnet, which, when energized, operates the release armature. This armature, striking a projection of the double dog, disengages both the vertical and rotary dogs from their respective toothed hubs, which permit the helical restoring spring

to return the shaft counterclockwise to disengage the wipers from the bank contacts, and free the shaft hub from the stationary dog, whereupon the shaft drops to its normal position.

Except for the vertical and releasing actions, controlled by the telephone station, the operations of the selector are entirely automatic.

The banks, shown in figure 1, are part of the shelf on which the selector mounts; thus if the bank rod nuts are removed and the selector taken off the shaft, the banks and bank rods would remain but would have no support other than the bank wiring.

3. FUNCTIONS

The major functions of the selector, in the order in which they take place, are:

3.1 Immediately upon seizure, to hold all preceding switches in the train operated and guarded until the holding (control) circuit is completed to the next (succeeding) switch in the train.

3.2 If it is a unit in a first-selector group, to connect dial tone to the calling line.

3.3 To raise the shaft and wipers in response to pulses from the dial.

3.4 To find and connect with an idle trunk in the selected bank level (rotary motion). This rotary motion comprises seven functions:

a. To rotate the shaft automatically.

b. To keep the line wipers disconnected during rotation.

c. To test the trunks successively.

d. To stop the rotary movement at the first idle trunk.

e. To protect the trunk selected until the holding (control) circuit is completed by the next (succeeding) switch in the train.

f. To extend the line through to the next (succeeding) switch in the train.

g. To disconnect all bridges or attachments from the transmission circuit.

3.5 If all trunks in the selected level are engaged, to return an audible busy signal to the caller.

3.6 When the caller hangs up, to release without interfering with other trunks.

4. SELECTOR TYPES

Two basic types of selector circuits have been used widely for many years. The older is spoken of as the "absence-of-ground-searching" selector, a term which refers to the means of marking trunks idle to the switch as it hunts across a selected bank level. The newer type is known as the "battery-searching" selector, a term which also refers to the means of marking trunks idle to the switch.

An absence-of-ground searching selector searches the trunk control leads for absence-of-ground which marks a trunk idle and allows the selector to stop (sections 6.3 and 6.6).

A battery-searching selector seeks negative battery on the trunk control lead (sections 5.3 and 5.4).

Busy trunks in both types of switchtrains are marked by ground on the control leads.

Because it is easier to understand, the battery-searching switch will be discussed first (section 5). By addition of two relays and a vertical bank assembly (figure 4), either type can be made to absorb digits as discussed in section 7.

5. BATTERY-SEARCHING SELECTOR

Figure 2 shows the circuit of a basic battery-searching selector for use in any selector rank. Dial tone is connected to first selectors only.

5.1 Seizure

When a battery-searching selector is seized, the preceding switch grounds lead C and connects the calling line and telephone across leads -LINE and +LINE.

When the preceding switch is a linefinder, it connects a 500-ohm noninductive bridge across -LINE and +LINE as soon as the linefinder starts hunting for the calling line. The bridge seizes and holds the selector until the calling line is found. When the calling line is found, the linefinder removes the 500-ohm bridge, and the calling line and telephone hold the selector.

The ground on lead C operates relay C, which, if this is a first selector, at make-before-break contacts 3-4-5 replaces direct ground with ground through a dial-tone transformer winding (not shown). Dial tone, induced into the winding, indicates to the calling line that the linefinder (or line switch) has finished its work and dialing may proceed. Dial tone is not provided in subsequent switches since the interdigital pause (time taken to pull a dial to the next desired digit) is long enough to allow a selector to hunt across and seize one of ten trunks on a level (section 5.3).

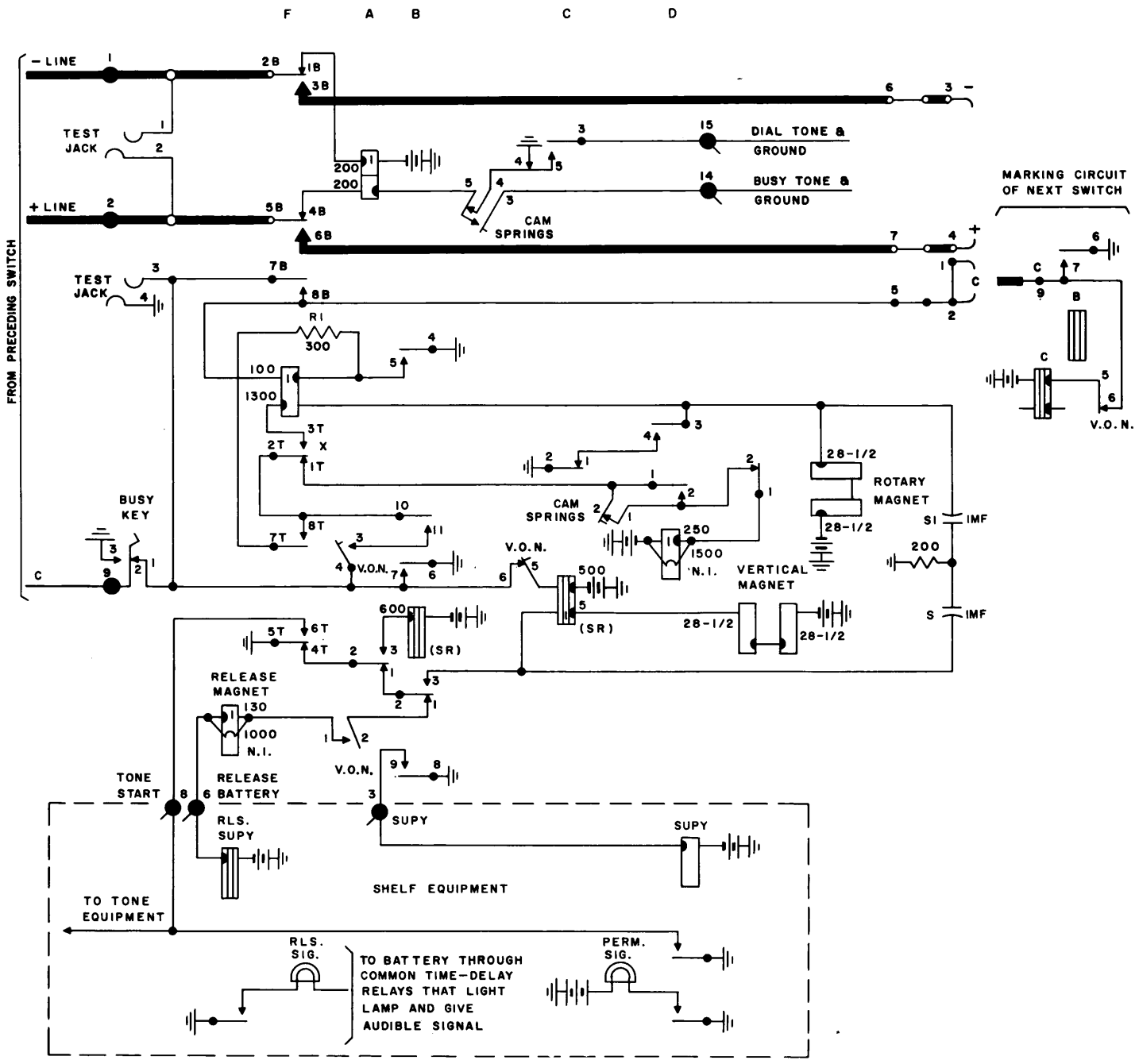


Figure 2. Battery-searching selector circuit.

Relay A operates through a circuit that includes a d-c loop and both its windings in series, and at contacts 2-3 completes a circuit to relay B.

Relay B operates, at contacts 6-7 closes what for the moment is an additional ground on lead C to hold the preceding equipment when it switches through (section 5.4) and, if it is other than a first selector, to mark the switch busy to other searching selectors. The same ground also holds relay C through its winding No. 2.

Operated, relay B at contacts 8-9 grounds lead SUPY (figure 2) to operate shelf supervisory relay SUPY. The supervisory relay in turn supplies a start signal for the tone equipment which was originally provided for by the preceding linefinder. In addition, the supervisory relay lights the PERM. SIG. lamp to indicate that a selector on this shelf has been seized.

5.2 Vertical Stepping

The caller pulls the dial off normal and releases it. During the return to normal, the dial pulse springs open the loop the number of times indicated by the dialed digit. Relay A releases during each open period, and at contacts 2-1 completes a circuit through relay B

contacts 2-3 to relay C winding No. 1 and in series with the vertical magnet. The copper sleeve on relay B keeps relay B operated although relay A contacts 2-3 open its circuit momentarily.

The vertical magnet operates, elevates the shaft one step, and the wipers are in line with the first level of bank contacts. For each succeeding pulse, the vertical magnet reoperates and raises the shaft and wipers one step or bank level.

While the shaft is being elevated the first step, the vertical off-normal springs are released mechanically. Vertical off-normal springs 3-4 complete a circuit through relay B contacts 11-10, relay F contacts 2T-1T, cam springs 2-1, and rotary magnet interrupter springs 2-1 to relay D. Relay D operates, at contacts 2-1 short-circuits cam springs 2-1 to insure that an eleventh rotary step (if required) can be completed (section 5.5), and at contacts 4-3 prepares a circuit for the rotary magnet. Vertical off-normal springs 5-6 open the circuit of relay C winding No. 2.

The copper sleeve on relay C keeps relay C operated throughout pulsing, although relay A contacts 2-1 open its circuit between pulses.

If the calling line is relatively long (and has few parties) high line resistance limits current flow. Relay A when magnetized, may be magnetized only weakly, releases quickly when the dial pulse-springs open, and reoperates slowly when they reclose. This gives relay C an extra-long pulse.

On the other hand, if the calling line is relatively short, relay A when magnetized is magnetized strongly, releases slowly, and reoperates quickly, giving relay C a short pulse.

Because relay A and relay C mount adjacent to each other, their magnetic fields interact. The other-than-usual connection of relay C (not ground, but negative battery connected to "in" terminals) causes the magnetic fields of relays A and C to augment each other. Thus when a long line magnetizes relay A only moderately, flux from relay C assists relay A. And when a short line magnetizes relay A so strongly that the pulse to relay C is short, the strong flux from nearby relay A adds to the magnetization from the Lenz'-law sleeve currents in relay C to help keep relay C operated between pulses.

5.3 Rotary Motion

After relay A reoperates following the last open period, relay C releases, at contacts 3-4-5 removes dial tone from the calling line, and at contacts 2-1 completes a circuit through relay D make contacts 3-4 to the rotary magnet. The rotary magnet operates, rotating the shaft and wipers to the first set of bank contacts (trunk No. 1 of the level selected). Just as the rotary magnet armature completes its stroke, it opens rotary interrupter contacts 1-2, to release relay D.

If the first trunk of the level selected is in use, ground (or open) will be encountered while selector control wiper C rests on the control bank contact, and switch-through relay F cannot operate. Relay D releases, opening the circuit of the rotary magnet. As the rotary magnet starts to release, interrupter contacts 1-2 reclose the circuit of relay D and the stepping cycle is repeated until an idle trunk is found (section 5.4) or all trunks test busy (section 5.5).

5.4 Switch-through

Negative battery marks an idle trunk, completing a circuit to switch-through relay F when wiper C engages the control bank contact. The negative battery on wiper C energizes winding No. 1 of relay F which operates its "X" contacts and at 1T-2T opens further the circuit of relay D. The "X" contacts 2T-3T of relay F provide a circuit to completely operate relay F. Negative battery through the rotary magnet, relay F winding No. 2, relay F "X" contacts 2T-3T, relay B make contacts 10-11, vertical off-normal springs 3-4 to ground at relay B make contacts 7-6 operate relay F. The "X" contacts (make contacts that close before all others) insure a locking circuit before ground at relay B contacts 6-7 short-circuits winding No. 1 via make contacts 7B-8B of relay F. Operated, relay F at contacts 1B-2B-3B and 4B-5B-6B releases relay A and extends the calling loop through to the next switch over the (-) and (+) wipers to seize the succeeding switch.

The combined operate time of relays A and B in the next switch is much less than the release time of relay B in this circuit, thus insuring that ground will be returned over wiper C to hold relay F operated before the circuit is broken at relay B contacts 6-7.

Operated, relay F locks to ground on wiper C from the next switch via its winding No. 1, resistor R1, relay F contacts 7T-8T, relay F contacts 2T-3T, and relay F winding No. 2 to battery on the rotary magnet. Also, ground on wiper C, via contacts 8B-7B of relay F, is extended to lead C to prevent the preceding switchtrain from releasing; and at 5T-6T grounds lead TONE START to keep the tone equipment operating.

When relay F operated completely, relay A released and at contacts 2-3 opened the circuit to slow-to-release relay B. Relay B releases and the next digit dialed steps the succeeding switch.

5.5 All Trunks Busy

If all ten trunks test busy, an eleventh rotary step is taken, at the start of which a cam attached to the shaft operates cam springs 1-2 to prevent relay D from reoperating after the eleventh step. Cam springs 3-5 make and 4-5 break to replace direct ground with ground through a busy-tone transformer winding to provide the calling party with an audible signal.

5.6 Release

Before switch-through relay F operates, the release magnet circuit is held open at relay A contacts 2-1 and at relay B contacts 2-1. If the caller hangs up before relay F operates, relay A and then relay B release, thereby completing the circuit of the release magnet. The release magnet armature strikes the double dog, disengaging its two detents from the vertical and rotary ratchets, thus permitting the shaft and wipers to return to their normal position.

When the selector has switched through, relays A and B are normal and the release magnet circuit is open at relay F break contacts 5T-4T. When the calling party disconnects with the selector in this position, the open calling loop releases relay A in the last switch of the train (usually a connector if the call has been completed). The corresponding relay B releases, removing ground from control lead C to release all switches in the train. Switch-through relay F releases, and at contacts 5T-4T completes the circuit of the release magnet. Notice that relay F, when operated fully, is held from ground on the C wiper through its windings No. 1 and 2 in series (opposing) through battery from the rotary magnet. Because the windings are opposed the release time of the relay is reduced thereby reducing the possibility of battery from relay D causing another selector, while hunting, to momentarily extend 100 ohm ground to lead C.

Just before the shaft reaches its normal position, the vertical off-normal springs reoperate. Springs 1-2 open the release magnet circuit. Springs 5-6 reconnect battery through relay C winding No. 2 to lead C to mark the switch idle.

6. ABSENCE-OF-GROUND-SEARCHING SELECTOR

Another local selector is the absence-of-ground-searching switch shown in figure 3. It is similar to the battery-searching selector, in that it also has five relays, uses relay interrupted rotary stepping, and has almost identical A, B, and C relays. It differs in that the switch-through relay has a single winding and is designed to operate from battery through the interrupter relay when not short-circuited by ground marking a busy trunk. The release magnet has contacts that ground lead C during release to give positive guarding, and relay C is not pre-energized over lead C. The mechanical arrangements are practically identical except that this absence-of-ground-searching switch has release magnet springs.

6.1 Seizure

When an absence-of-ground-searching selector is seized, the seizing switch closes a d-c circuit across leads -LINE and +LINE. Note that, when idle, the switch is marked by neither ground nor battery on lead C and that even though the seizing switch (linefinder H-75311 or similar) does ground lead C, relay C is not operated thereby.

Relay A operates, and at contacts 2-3 completes the circuit of relay B. Dial tone and ground is connected, through relay A winding No. 2, to the calling line at the time of seizure. Relay B operates, at contacts 4-5 grounds lead C to mark the switch busy and to hold the preceding switches, at contacts 6-7 completes the circuit of relay C winding No. 2, and at contacts 8-9 prepares a circuit for relay E.

Relay C operates, and at contacts 4-6 short-circuits unoperated relay D.

6.2 Vertical Stepping

Relay A follows the dial pulses, releasing during each open loop period to pulse relay C winding No. 1 in series with the vertical magnet. The vertical off-normal springs release during the first vertical step. Vertical off-normal springs 5-6 open the circuit of relay C winding No. 2 (but pulses through winding No. 1 keep relay C operated throughout vertical stepping).

Vertical off-normal springs 3-4 close a circuit as follows: from ground at relay B contacts 4-5, through release magnet springs 2-3, relay C springs 6-4, relay B springs 9-8, rotary magnet interrupter springs 2-1, and vertical off-normal springs 3-4, to relay E. Relay E operates, locks, and places an additional short-circuit around relay D.

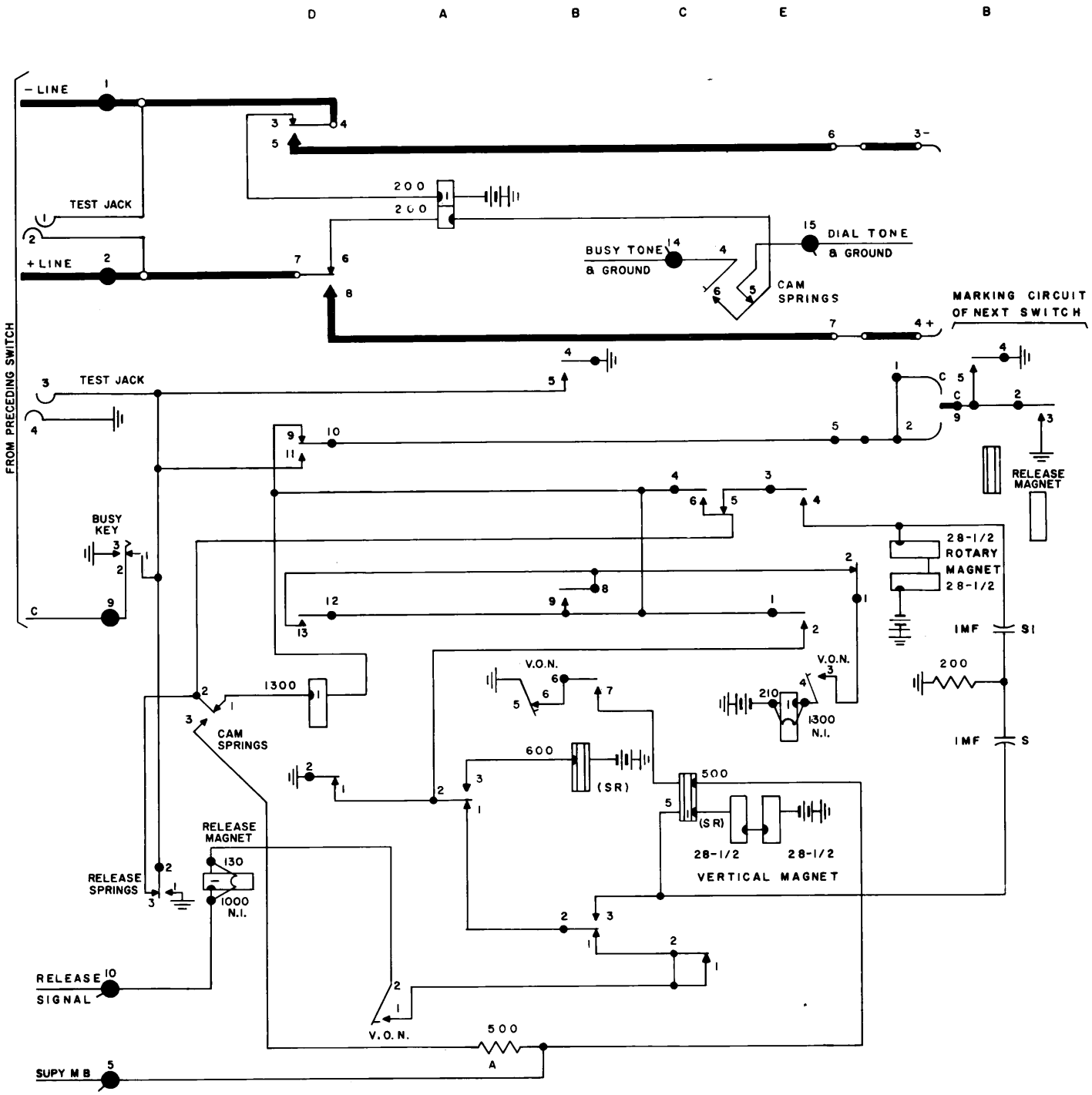


Figure 3. Absence-of-ground searching selector circuit.

After the last vertical step, relay C releases, removes one short-circuit from around relay D, and completes a circuit as follows: from ground at relay B contacts 4-5, through release magnet springs 2-3, relay C springs 6-5, and relay E springs 3-4 to the rotary magnet.

6.3 Rotary Stepping

The rotary magnet operates, and rotates the shaft and wipers to the first set of bank contacts. After the wipers are on these first contacts, and just as the rotary magnet armature completes its stroke, rotary magnet interrupter springs 1-2 open the circuit of relay E. Relay E releases, removes its short-circuit from relay D, and opens the circuit of the rotary magnet.

If the first trunk is busy, ground encountered by wiper C keeps relay D short-circuited. Also, as the rotary magnet releases, rotary interrupter springs 2-1 connect the wiper C ground to relay E. Relay E operates, locks,

puts an additional short-circuit across relay D, and operates the rotary magnet, stepping the wipers to the next trunk.

6.4 Switch-through

Absence-of-ground marks an idle trunk. When the rotary magnet starts to release after rotating the wipers to such a trunk, interrupter contacts 1-2 close battery from the winding of relay E to relay D. The only ground completing a circuit to relay E now comes through the 1300-ohm winding of relay D, and the resultant current is enough to operate only relay D.

Relay D operates, at contacts 13-12 provides itself an additional path through relay E to negative battery for use when relay B releases, at contacts 2-1 opens the circuit of relay B, at contacts 3-4-5 and 6-7-8 disconnects relay A and extends the calling loop through to the next switch, and at contacts 11-10 connects wiper C to lead C so that the next switch, returning ground over wiper C, can hold this and preceding switches. Also at relay D contacts 6-7, dial tone and ground are removed from the calling line.

Relays A and B in this switch release.

6.5 All Trunks Busy

If all ten trunks test busy, an eleventh rotary step is taken, at the start of which a cam attached to the shaft operates cam springs 2-3 to prevent relay D from operating as soon as relay E releases at the end of the eleventh step. The wipers are off the banks and relay E cannot reoperate. Cam springs 4-6 connect busy tone to the calling line.

6.6 Release

Release is similar to that of a battery-searching selector (section 5.6) except that in an absence-of-ground searching switch, release magnet springs 2-3 disconnect relay D from lead C and springs 1-2 ground lead C to mark the switch busy.

7. DIGIT ABSORBING SELECTOR

When two neighboring automatic exchanges are interconnected by free-service dialing trunks, it is desirable to use "universal numbering" and have the first selectors in each office "absorb" the first digit dialed when it indicates the local exchange to save a rank of selectors in each office. Figure 5 shows a 2-5 digit-absorbing selector. The switch shown is an absence-of-ground searching selector, but the digit-absorption feature is available also for battery-searching selectors. Notice that two additional relays, Z and D, are used; that a vertical bank is added (figure 4) and wired

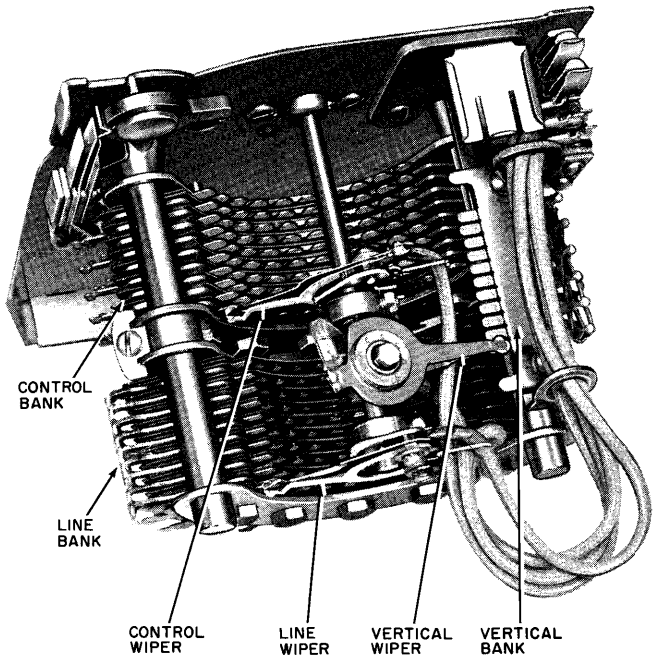


Figure 4. Vertical and rotary bank assemblies.

to operate when a digit-absorbing or single digit cut-in level is reached during vertical stepping; that normal post springs are used to prevent incorrect dialing sequence; and that the release magnet is equipped with contact springs.

7.1 Seizure

When an absence-of-ground-searching selector is seized, the seizing switch closes a loop via -LINE and +LINE to relay A windings No. 1 and 2. Relay A operates and at contacts 2-3 completes a circuit from ground at relay F contacts 2B-1B, through relay A contacts 2-3, to battery at relay B. Relay B operates, at contacts 10-11 grounds lead C to mark the switch busy and to hold the preceding switches, at contacts 8-9 completes a circuit to relay C winding No. 2, at contacts 7-6 grounds lead SUPY, at contacts 12-13 prepares a circuit to relay Z, at contacts 4-5 prepares a circuit to relay E, and at contacts 2-3 prepares a circuit to relay C winding No. 1 in series with the vertical magnet.

Relay C operates from ground at relay B contacts 8-9, through relay F contacts 5B-4B, vertical off-normal springs 6-7, to battery at relay C winding No. 2. Relay C contacts 7-9 close dial tone and ground to the calling line, and contacts 5-6 prepare a circuit to relay E.

7.2 Vertical Stepping

Relay A follows the dial pulses. Relay A at normal, opens relay B, and closes ground to relay C winding No. 1 in series with vertical

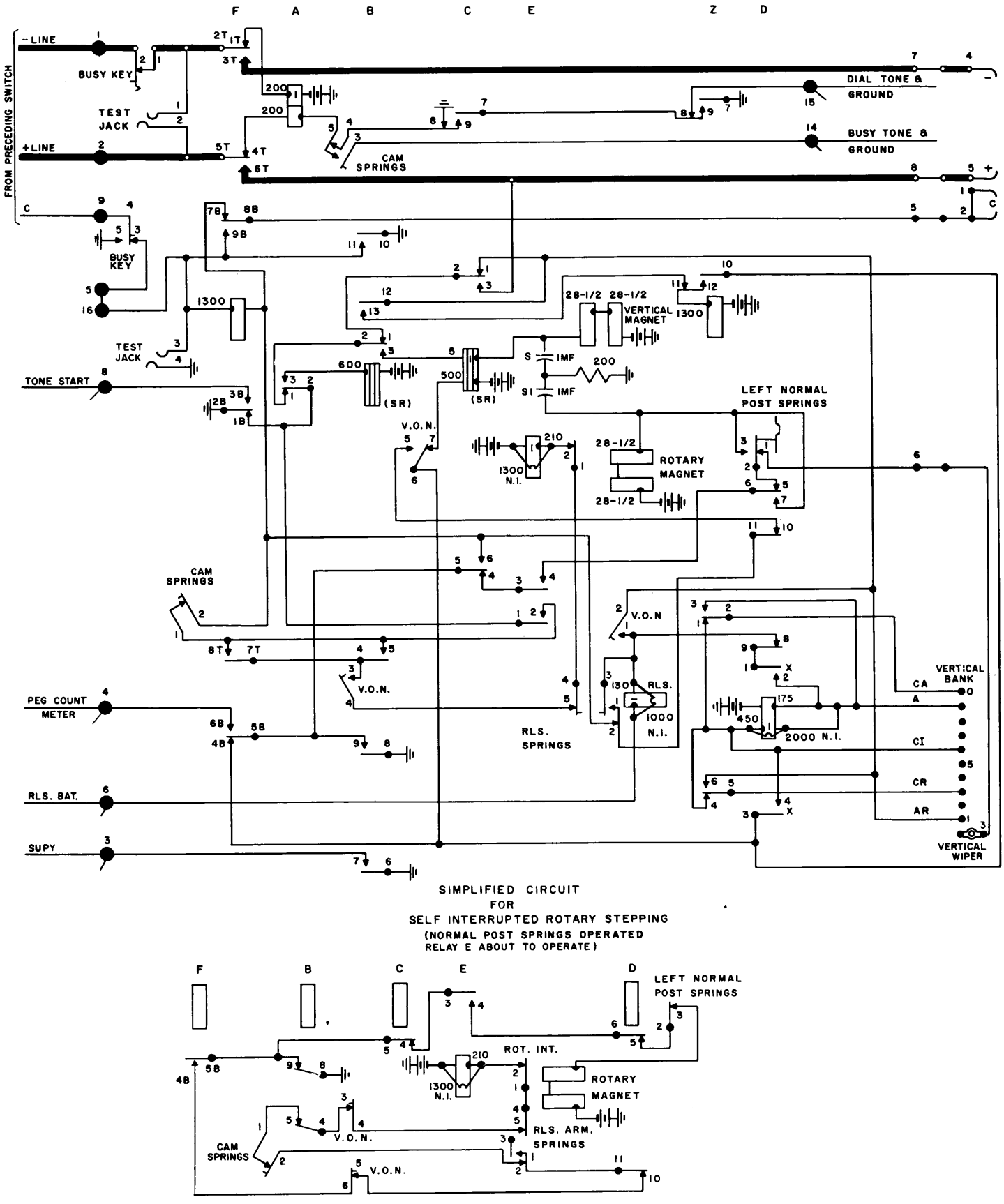


Figure 5. Digit-absorbing selector circuit (absence-of-ground searching).

magnet. Relays B and C remain operated during pulsing because they are slow to release. The vertical off-normal springs release during the first vertical step. Vertical off-normal springs 5-6 open the circuit to relay C winding No. 2 (but pulses through winding No. 1 keep relay C operated throughout vertical stepping).

Vertical off-normal springs 3-4 complete a circuit to relay E from ground at relay B contacts 8-9, through relay C contacts 5-6, to cam springs 2-1, relay B contacts 5-4, vertical off-normal springs 3-4, release armature springs 5-4, rotary magnet interrupter springs 1-2, to battery at relay E. Relay E operates, locks, and at contacts 3-4 prepares a circuit to the rotary magnet. After the last vertical step, relay A reoperates and opens the circuit to the vertical magnet and relay C winding No. 1. The vertical magnet restores.

7.3 Single Digit Cut-in

If a single digit is to be permitted to select and cut-in to a level (that is, not to be "absorbed") when vertical stepping ends, lead CI, CA, or CR is wired to a contact on that level of the vertical bank. Lead CI is used when cut-in is required on any digit dialed. Leads CA and CR are used when cut-in is required on the first digit only. If lead CA is the second digit its operation, circuitwise, will be that of a lead A (section 7.4) digit; thus the third digit will cut in on any level. If lead CR is the second digit its operation, circuitwise, will be that of a lead AR (section 7.5) digit; thus the third digit must be either a lead A or CA so that the fourth digit will cut in on any level. Note that lead CI will cut in every time it is dialed.

When relay C releases after vertical stepping, a circuit is closed from ground at relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, relay D contacts 6-5, left normal post springs 1-2, vertical bank wiper, lead CI (if single digit cut-in is desired), to relay D windings No. 1 and 2 in series. Relay D operates its "X" contacts, closes relay Z, operates fully, contacts 11-10 open and remove ground from wiper C, and at contacts 6-7 completes a path to the rotary magnet to start rotary stepping (section 7.7). Relay Z operates, locks, and at contacts 7-9 removes dial tone and ground from the calling line.

7.4 Digit Absorbed Once Only

If the dialed digit is to be ineffective in selection of, and is to be denied access to the level once only (that is, if the digit is to be "absorbed", and the switch shaft is to return to normal, to start over when the next digit is dialed), when vertical stepping ends, lead A is wired to the vertical bank contact associated with that level; thus any digit which follows a lead A digit will be cut in.

When relay C releases, after vertical stepping, it closes a circuit from ground at relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, relay D contacts 6-5, vertical bank contact A, to relay D winding No. 2. Relay D operates its "X" contacts only; "X" contacts 1-2 close a circuit to the release magnet and relay Z, and "X" contacts 3-4 short circuit relay D winding No. 1. Relay Z operates, locks, and at contacts 7-9 disconnects dial tone and ground. The release magnet operates, locks, and at contacts 5-4 opens relay E, and releases the switch shaft. Relay E restores. As the shaft falls away from the level dialed and returns to normal, it removes the short circuit from relay D winding No. 1. Vertical off-normal springs 1-2 operate and open the release magnet circuit and vertical off-normal springs 7-6 operate and close a circuit to relay C winding No. 2. With its two windings in series relay D operates fully. Relay C operates and the release magnet restores. The switch is now ready for another digit. However, since relay D is operated and locked, when relay C restores at the end of vertical pulsing of the second digit, a circuit is closed from ground at relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, and relay D contacts 6-7 to the rotary magnet which operates and starts rotary hunting (section 7.7); thus any digit following an A level digit will be cut in.

7.5 Digit Absorbed Repeatedly

If a dialed digit is to be "absorbed" repeatedly, when vertical stepping ends, lead AR is wired to the vertical bank contact associated with that digit absorbing level.

When relay C releases after vertical stepping, it closes a circuit from ground at relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, relay D contacts 5-6, vertical bank contact AR, and vertical off-normal springs 2-1 to the release magnet. This same ground also closes a circuit to relay Z, which operates and locks. The release magnet operates, locks, and at release armature springs 5-4 opens the circuit to relay E, and releases the switch shaft. Relay E restores.

When the switch shaft returns to normal, vertical off normal springs 1-2 operate and open the release magnet circuit; also vertical off-normal springs 6-7 close a circuit to relay C winding No. 2. Relay C operates and the release magnet restores. The switch is now ready to accept another digit.

Relay Z remains operated; thus if the second digit dialed is a lead CR digit, it would be absorbed the same as an AR digit. The circuit for this is as follows: ground from relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, relay D contacts 5-6, vertical bank contact CR, relay Z contacts 5-6, vertical off-normal springs 2-1, to battery at the release magnet. Absorption takes place the same as above.

If a lead AR digit follows a lead A digit, the AR digit will cut in because the lead A digit had locked relay D and prepared a circuit to step the rotary magnet on any subsequent digit.

7.6 Preventing Incorrect Dialing Sequence

If an incorrect preliminary digit is dialed, after vertical stepping, the switch shaft comes to rest operating the left normal post springs. Operation of left normal post springs 2-3 removes ground from the vertical wiper, and closes a circuit from relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, relay D contacts 6-5, and left normal post springs 2-3 to the rotary magnet. The rotary magnet operates (section 7.7) and steps relay-interrupted to the eleventh rotary bank position, where the cam springs operate. Cam springs 3-5 operate and connect busy tone through relay A winding No. 2, and relay F contacts 4T-5T, to the positive line.

If a digit to be absorbed once only is dialed first, followed by a digit that operates the left normal post springs the operation of the left normal post springs is ineffective. Relay D operates after the first digit and prepares a circuit to the rotary magnet; thus the succeeding digit will be cut in.

7.7 Rotary Stepping

If a dialed digit causes relay D to operate fully, or the left normal post springs to operate, rotary stepping will take place. The rotary magnet operates from ground at relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, relay D contacts 6-7, to battery at the rotary magnet. With relay D unoperated and the left normal post springs operated the circuit is from ground at relay B contacts 8-9, through relay C contacts 5-4, relay E contacts 3-4, relay D contacts 6-5, and left normal post springs 2-3 to battery at the rotary magnet. The rotary magnet operates, rotating the shaft to the first set of bank contacts. As the rotary magnet armature completes its stroke, it opens rotary interrupter springs 1-2, to release relay E. If the first trunk is busy, ground encountered by wiper C keeps relay F short-circuited. The release of relay E opens the circuit to the rotary magnet. The rotary magnet releases and rotary interrupter springs 2-1 connect wiper C ground to relay E. Relay E operates, locks, puts an additional short circuit across relay F and operates the rotary magnet, stepping the wiper to the next trunk. This cycle continues until either an idle trunk is found or all trunks test busy.

7.8 Switch-through

If the rotary wiper C finds absence of ground, the rotary magnet starts to release. Rotary interrupter springs 2-1 close battery from relay E through release magnet springs 4-5, vertical off-normal springs 3-4, relay B contacts 4-5, cam springs 1-2, and the 1300-ohm winding of relay F to ground at relay B contacts 11-10. The resultant current is enough to operate only relay F. Relay F operates, locks, opens relays A, B, Z, and D, at contacts 2T-3T, 5T-6T, and 8B-9B, connects -LINE, +LINE, and C LEAD to -, +, and C wipers respectively; thus extending the calling loop through to the next switch. At contacts 6B-5B grounds lead PEG COUNT METER, and at contacts 2B-3B grounds lead TONE START. Ground from the succeeding switch is returned over wiper C to lead C to hold this and preceding switches operated. Relays A, D, and Z restore. After its slow-to-release interval, relay B restores, and removes ground from leads PEG COUNT METER and SUPY.

7.9 All Trunks Busy

If all ten trunks test busy, an eleventh rotary step is taken, at the start of which a cam attached to the shaft operates cam springs 1-2 to open the circuit of relay E and prevent it from operating after the eleventh rotary step. Cam springs 3-5 close busy tone and ground to the calling line.

7.10 Release

7.10.1 After switch-through.

When the calling party disconnects and opens the loop to the succeeding switches, ground is removed from the C wiper and relay F. Relay F restores, disconnects leads +LINE, -LINE, and C from their respective wipers. At relay F contacts 2B-1B disconnects lead TONE START, and completes a circuit to the release magnet. The release magnet operates, locks, and releases the switch shaft. As the shaft returns to normal, vertical off-normal springs 2-1 operate and open the circuit to the release magnet, which restores. The switch is now at normal.

7.10.2 From all-trunks-busy condition.

If all trunks are busy, the wipers rotate to the eleventh rotary step and operate the cam springs which close busy tone and ground to the calling line. When the calling party is disconnected from the line, the preceding switches are released and the circuit to relay A is opened. Relay A restores and opens the circuit to relay B. After its slow-to-release period, relay B restores. At relay B contacts 7-6 lead SUPY is opened. The release of relay B also opens the circuit of relays Z and D, which restore. Ground is closed from relay F contacts 2B-1B, through relay A contacts 2-1, relay B contacts 2-1, relay C contacts 2-1, and vertical off-normal springs 2-1 to the release magnet. The release magnet operates and releases the switch shaft. As the shaft returns to normal the cam springs restore and remove busy tone and ground from the calling line, and the vertical off-normal springs operate and open the circuit to the release magnet. The release magnet restores and the switch is at normal.

8. SUPERVISORY LEAD

To start dial and busy tone for the selectors, and to give a visual indication when a selector is being held by a "permanent" or grounded line, a supervisory lead is provided on both selector types and is grounded by selector relay B. The supervisory lead (SUPY) is common to all selectors on a shelf and terminates in a relay (figure 2) which starts the tone equipment and lights a shelf supervisory lamp.

Another supervisory relay (figure 2), in the release battery lead, gives an alarm if any release magnet on the shelf remains operated longer than is normal.

9. TONE START LEAD

The selector switch-through relay (figure 2 relay F for example) grounds lead TONE ST (tone start) to start the busy tone source for the connectors.

10. SPARK PROTECTION

The noninductive windings connected in parallel with the operating windings of the interrupter relays and the release magnets offer low impedance paths for current surges when the associated circuits are opened, thus reducing sparking at the contacts which open the circuits. To protect contacts in the highly inductive vertical and rotary magnet circuits, the contacts are bridged by capacitors which absorb the surge when the contacts open the circuit. The capacitors are connected in series with a resistor which limits the discharge current when the contacts first reclose. For example, in figure 2, capacitor S and the associated 200-ohm resistor bridge relay A contacts 2-1 during vertical stepping. Capacitor S1 and the same 200-ohm resistor bridge relay D contacts 3-4 during rotary stepping. Special precious metal contacts, labeled IV on the circuit diagrams, are used for interrupter contacts and for contacts, such as figure 2 vertical off-normal springs 1-2, that break the release magnet circuit.

11. BUSY KEY AND TEST JACKS

A busy key is provided to allow immediate removal of a switch from service. Operated, a busy key will ground lead C to prevent all preceding switches from stopping at the busied position. The test jacks are provided to facilitate testing and troubleshooting of a switch without removing the switch from its position. A hand test telephone can be inserted into the test jacks to enable a switchman to perform local tests.