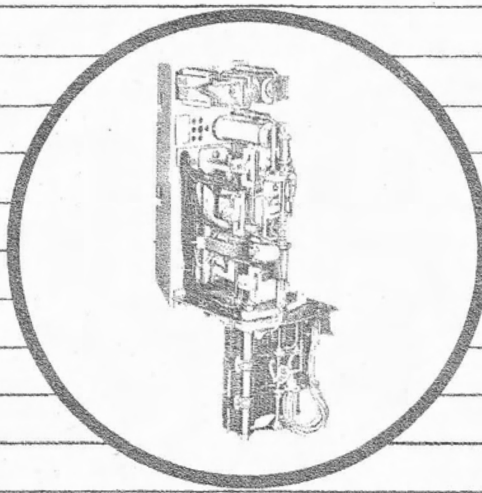
The Lin... der 821

AUTOMATIC ELECTRIC TRAINING SERIES | Bulletin **821**

The LINEFINDER

STROWGER AUTOMATIC TELEPHONE SYSTEMS



AUTOMATIC ELECTRIC®

ORIGINATORS OF THE DIAL TELEPHONE

1033 WEST VAN BUREN STREET, CHICAGO, 7, ILLINOIS, U.S.A.

This is one of the helpful booklets in the
AUTOMATIC ELECTRIC TRAINING SERIES
on
STROWGER AUTOMATIC TELEPHONE SYSTEMS

800 Electrical Principles of Telephony
801 Mechanical Principles of Telephony
802 Fundamentals of Apparatus and Trunking
805 The Plunger Lineswitch and Associated Master-Switch
806 Rotary Lineswitch
807 The Connector
808 The Selector
810 Pulse Repeaters
811 Trunking
812 Power and Supervisory Equipment
813 Party-Line Connectors and Trunk-Hunting Connectors
814 Reverting-Call Methods
815 The Test and Verification Switch Train
816 Toll Switch Train
817 Switching Selector-Repeater
818 Private Automatic Exchanges with PABX Appendix
819 Community Automatic Exchanges
820 Manual Switchboards
821 Linefinder Switches

May we send you others
pertaining to equipment in your exchange?

CONTENTS

LINEFINDER SWITCHES

Bulletin 821

1. THEORY

1.1 Introduction. At no one time will all subscribers of a telephone exchange use their telephones simultaneously. Therefore, an automatic exchange need provide links to accommodate just a fraction of the subscribers at any one time (as in manual offices where the number of cord circuits is just a fraction of the number of lines). Since there are fewer links than lines, the links are placed in a pool, to be used by the lines as needed. A device is required to connect a calling line to an idle link. It may be a rotary lineswitch (Automatic Electric Company bulletin 806), a plunger lineswitch (bulletin 805), or an "all-relay" linefinder (bulletin 403). However, the most common way to connect a calling line to an idle link is with a "linefinder", a Strowger switch equipped with appropriate relays and bank contacts — usually to serve 200 lines.

Since the linefinder hunts for a marked line, rather than being positioned by dial pulses as are connectors and selectors, it is known as a non-numerical switch.

1.2 The 100-line linefinder. Under control of its relays, the 100-line linefinder can connect any of one hundred lines to one link. When the subscriber lifts his handset, the line equipment associated with his line (figure 2) operates, busies the calling line to other callers, marks the line's contact on the linefinder banks, and starts the linefinder. The linefinder lifts its wipers to the level that the line is in, rotates its wipers to the calling line's contacts, and switches the calling line through to the first selector (or connector) which returns dial tone notifying the calling party to dial. The only action upon the part of the subscriber has been the lifting of the handset.

1.3 100-line linefinder shelf. More than one link is needed to handle the traffic from one hundred lines and so a number of linefinders are provided. A distributor switch, under control of relays common to the group, determines which linefinder will serve the next calling line. The finders, banks, group relays, distributor, line equipment, and the frame on which they are mounted, are known as a "linefinder shelf". When a subscriber lifts his handset, his line equipment busies his line to other callers, marks his contact on all linefinder banks, and activates the group relays. The group relays cause the linefinder connected to them by the distributor to connect its wipers to the calling line's contacts. The linefinder switches the calling line through to the first selector (which returns dial tone to the calling party), causes the distributor switch to step to the next idle linefinder, and releases the group relays which now are ready for another call. The distributor in allotting an idle link to each calling line, also equalizes the wear on the linefinders.

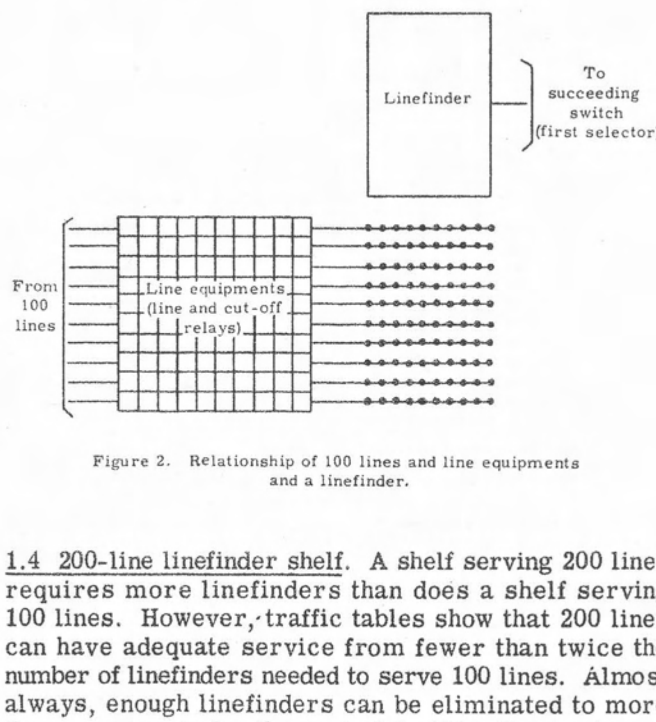


Figure 2. Relationship of 100 lines and line equipments and a linefinder.

1.4 200-line linefinder shelf. A shelf serving 200 lines requires more linefinders than does a shelf serving 100 lines. However, traffic tables show that 200 lines can have adequate service from fewer than twice the number of linefinders needed to serve 100 lines. Almost always, enough linefinders can be eliminated to more than compensate for the cost of doubling the number of bank contacts. Thus, 200-line finders are almost universally preferred and will be the subject of this bulletin. These finders operate just as the 100-line finders except that, after the wipers are stepped up and around, there are two sets of wipers touching two sets of bank contacts. The linefinder relays, however, connect just the calling line's contacts to the first selector (or connector).

1.5 Preferential hunting. Any calling line can be reached with a maximum of twenty steps of the linefinder, ten steps up and ten steps across. The average hunting time is reduced by reversing the bank multiple (figure 3). Then all lines are in the lower five levels of some linefinders' banks and can be reached in a maximum of fifteen steps, five up and ten across. The finders having each hundred's lower-numbered line equipments connected to the banks' lower five levels are called group A finders. The finders having each hundred's higher-numbered line equipments connected to the banks' lower five levels are called group B finders. (Figures 3 and 12). With this arrangement, two distributors and two relay groups are necessary. A lower-numbered line equipment activates group A relays which start a preselected group A linefinder. A higher-numbered line equipment activates group B relays and a group B linefinder. This is known as "preferential hunting". A group A and a group B linefinder can be hunting simultaneously. If a low-numbered line equipment operates and all group A linefinders are busy, it will activate the group B relays which will cause a group B linefinder to connect to the line. Group A linefinders will likewise assume the group B linefinders' load when all group B linefinders are busy. This feature is valuable not only to give faster service but also permits routining the switches and group relays without denying service to any subscriber.

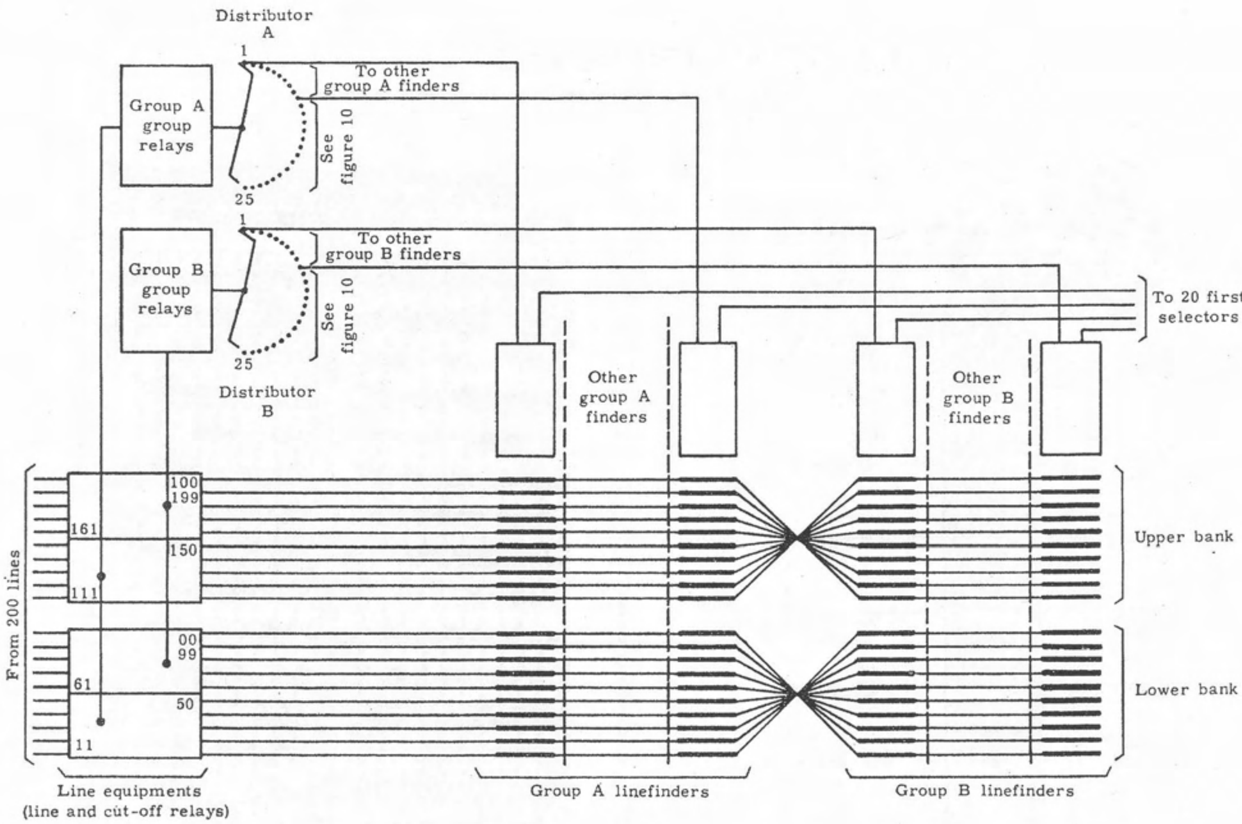


Figure 3. Two-hundred-line linefinders with bank reversal for preferential hunting.

2. PHYSICAL ARRANGEMENTS

2.1 Variations. A linefinder shelf consists of linefinders, group relays, distributors, line relays, associated equipment, and the frame on which they are mounted. Each shelf is assembled, wired, and shipped as a complete unit, ready for mounting on an open frame. Linefinder shelves come in a variety of sizes and shapes depending upon the frames on which the shelves are to be mounted, the number of linefinders in the shelf, the type of line equipment (1-relay, 2-relay, or 3-relay), the type of metering, whether restricted service is furnished, and whether the shelf accommodates overflow finders. Figures 4A, 4B, and 5 show three typical linefinder shelves (in figures 4A and 5 all dust covers have been removed). The linefinder shelf is mounted on a large iron frame. The frontispiece (figure 1) shows two linefinder frames, each mounting four linefinder shelves. The eight white cards at the lower right of each frame show the connector terminal or terminals connected to each line equipment.

2.2 Overflow shelves. All working lines of an exchange should be distributed evenly between the different linefinder groups. Each group of lines should be a representative group so that every linefinder group handles approximately equal traffic. Each linefinder shelf should be equipped with just enough linefinders to

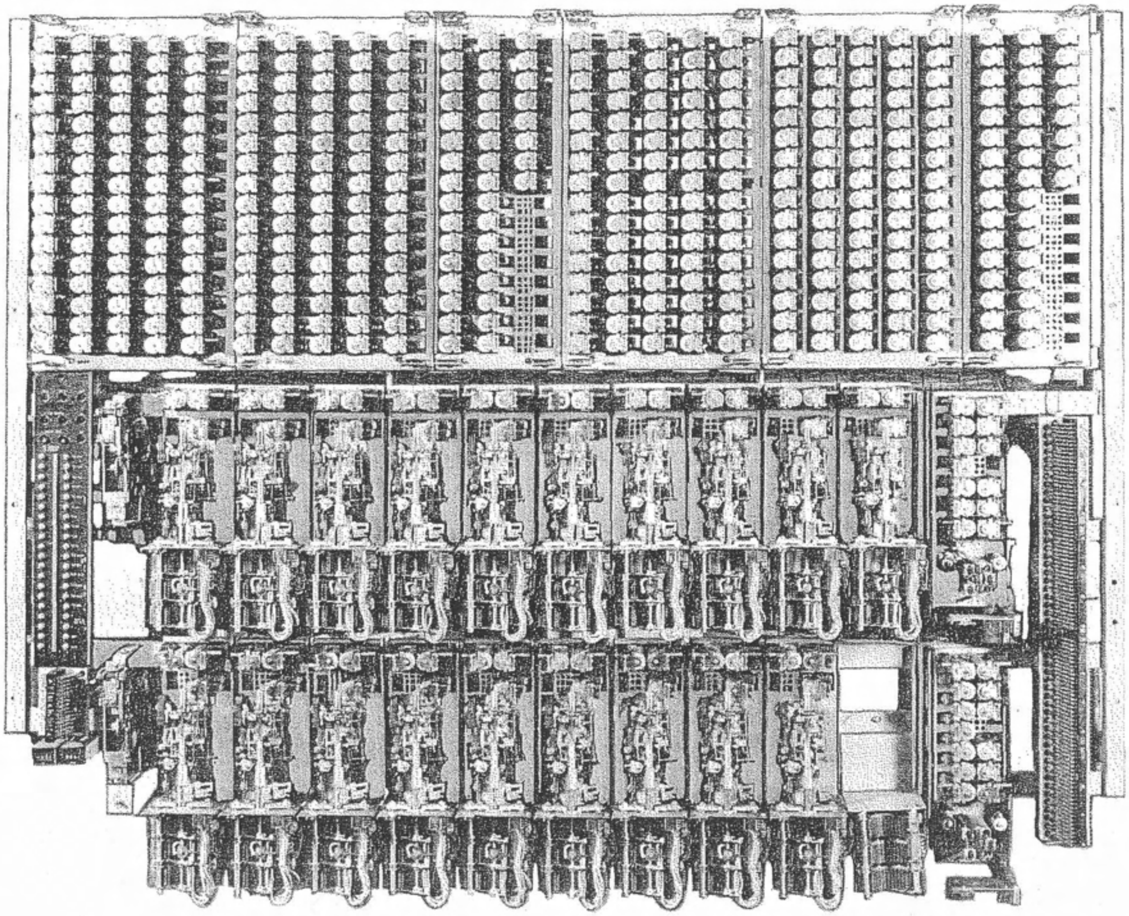


Figure 5. Two-hundred-line linefinder shelf with linefinders mounted below line and cut-off relays. Used with type 11 equipment frames 9' tall.

take care of its traffic. Sometimes the traffic originating in 200 lines requires more linefinders than can be mounted on the linefinder shelf. Then a shelf mounting nothing but linefinders and banks is utilized. These linefinders are connected to the group relays and the distributors of the 200 lines just as are the regular finders. These linefinders operate just as the regular linefinders. The bank multiple of this shelf is reversed in the middle so that the number of finders in group A and group B are kept about equal. This shelf is called an "overflow" shelf since the number of finders needed "overflow" the regular linefinder shelf. (Overflow shelves do not handle just "overflow" traffic. The linefinder shelf treats an overflow finder essentially the same as a regular finder). For shelves of the type shown in figure 4, the overflow finders mount at the left of the regular finders. For shelves of the type shown in figure 5, the overflow finders mount either just below the regular finders or on a non-adjacent frame. See also figure 10.

2.3 Connections. A linefinder shelf requires the following connections: two 305-conductor cables to connect the linefinders to the +, -, and C of the 200 lines; one cable to connect the linefinders to the first selectors; ground and battery cables for power; and a 12-conductor signal cable to supply busy tone, class-of-service tone, alarm leads, timing leads, and so forth. An overflow shelf requires one cable to connect the linefinders to the first selectors and battery and ground cables for power. Two 305-conductor cables connect the banks of a regular shelf and its overflow shelf together.

3. COMPONENTS

3.1 Line equipments. One line equipment is associated with each working line. When a subscriber lifts his handset from the hookswitch to make a call, his line equipment (1) busies that line to other calls, (2) marks the position of the calling line in the linefinder banks, (3) signals the group relays to start a linefinder, and (4) when a linefinder has found him, clears the line of attachments. Also, when a subscriber is called, his line equipment clears his line of attachments.

Line equipments are supplied in groups, assembled and wired on a steel plate which is bolted to a linefinder shelf. The line equipments are numbered from 00 to 199. (The line-equipment number bears no relationship to the directory number of the telephone to which it is connected. Through the distributing frame, any outside line may be connected to any line equipment.)

A two-relay line circuit is shown in figure 6. When the subscriber lifts his handset to make a call, ground through springs on the cut-off relay (CO), the + line, the subscriber's telephone, the - line, springs of relay CO, and the line relay (L) operates relay L. Relay L grounds connector control lead CN, busying the line to other calls, connects negative battery through relay CO to linefinder control lead CF to mark this line's contacts on the linefinder banks, and grounds lead LEV. ST. to mark the level on which the calling line will be found and to signal the group relays to start a linefinder. The linefinder, connecting to this line, grounds lead CF operating relay CO. Relay CO locks, and removes relay L from across the subscriber's line. Relay L releases, and removes ground from lead LEV. ST. When

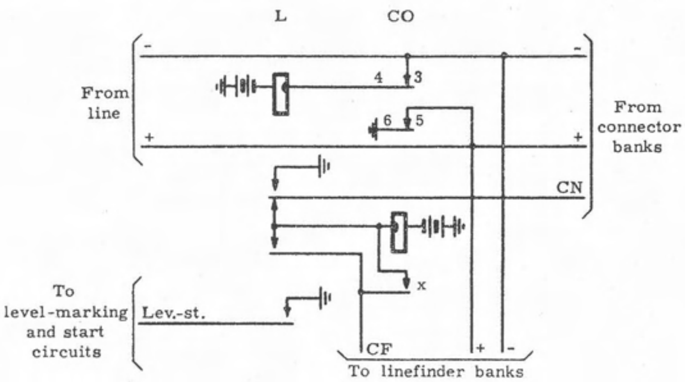


Figure 6. Usual 2-relay line circuit.

the subscriber receives a call, the connector grounds lead CN to operate the cut-off relay. The cut-off relay "cuts off" or removes relay L from the line.

Less usual is a one-relay line circuit (figure 7) which consists of a two-step relay, so called since only its contacts marked "X" close when a circuit is closed through its three windings in series. All contacts operate fully when 48 volts are connected to winding 1 alone.

When the subscriber lifts his handset, ground through winding 2, springs of relay L, the + line, the subscriber's telephone, the - line, springs of relay L, winding 3, and winding 1 magnetizes relay L. Contacts "X" connect relay L winding 1 to the linefinders' control contact (CF) to mark the line on the linefinder banks, and ground the level-start lead to signal the group relays to start a

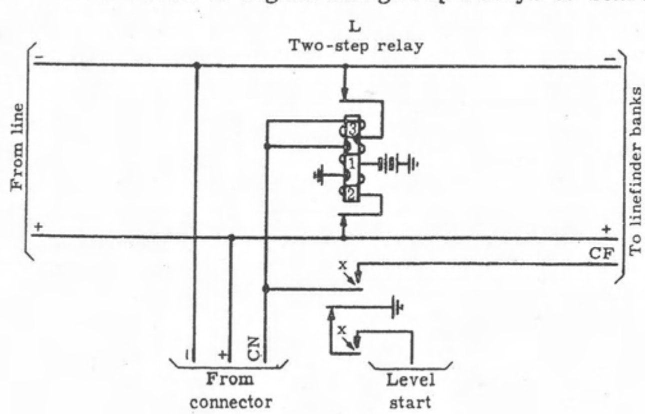


Figure 7. One-relay line circuit, using "2-step" relay.

linefinder. When the linefinder connects to this line, it grounds line-equipment lead CF (and thereby connector lead CN) to busy the line to other calls and to operate relay L fully. Relay L, operating completely, removes ground from the level-start lead and removes relay L from across the line.

Lock-out line equipments are described in §6.4.

Class-of-service tone (usually dial tone) often is connected to lead C of the line equipment of a semi-postpay paystation. When the paystation calls an operator, a splash of tone warns the operator that the call is from a paystation; that is, that mere ticketing for tolls will not suffice—tolls must be collected.

3.2 Group relays. Operation of the linefinders of each group is controlled by a group-relays assembly. As soon as a line equipment grounds lead LEV. ST., the associated group relays cause a preselected linefinder to hunt for and connect with the calling line. After switching the calling line through to the first selector, the linefinder steps the distributor switch to the next idle linefinder. The group relays then release and are available to operate another linefinder when another line calls.

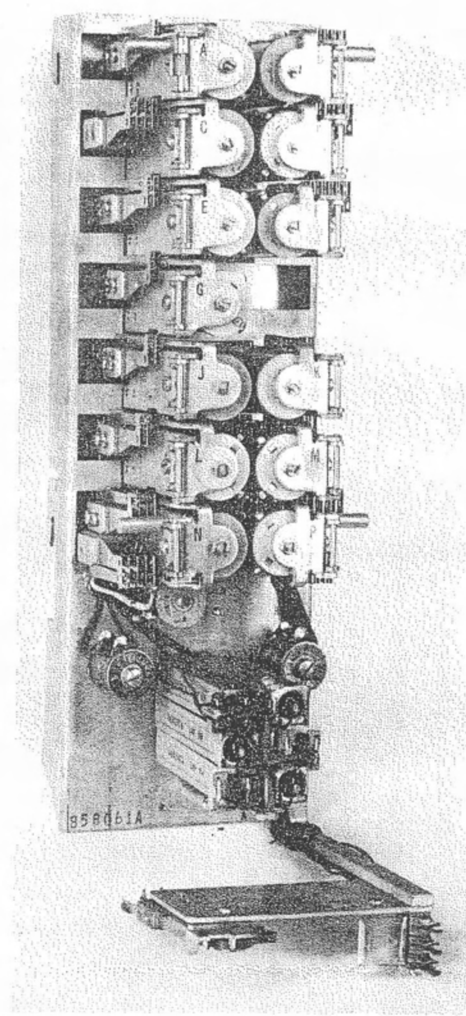


Figure 8. Group relays.

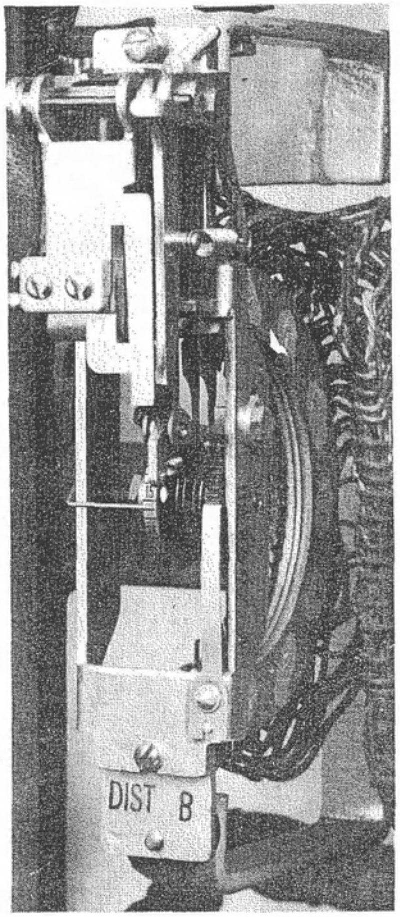


Figure 9. Distributor.

A typical group-relays assembly consists of thirteen relays, five resistors, three capacitors, and two rectifiers, mounted on a base plate (figure 8). A metal cover (not shown) protects the assembly from dust and physical injury. An extension frame at the bottom of the base plate mounts (from left to right) a busy key, a number-plate holder, and a test jack. Operation of the busy key causes the other group's linefinders to find this group's calling lines. The number-plate holder mounts a card showing the number of the finder and also the location and number of its associated selector. The purposes of the test jacks are described in §6.5. The group relays can be jacked in and out rapidly and conveniently. Two pairs of shelf-jack contacts close when the group relays are removed from the linefinder shelf, making it possible for that group's lines to be served by the other group's finders.

Distributor wiper position	Linefinders mounted beside line and cut-off relays as in figure 4				Linefinders mounted below line and cut-off relays as in figure 5			
	20-finder shelf		26-finder shelf		20-finder shelf		30 finders (20-finder shelf and 10 "overflow" finders)	
	Group A finder no.	Group B finder no.	Group A finder no.	Group B finder no.	Group A finder no.	Group B finder no.	Group A finder no.	Group B finder no.
1	1	11	1	14	1	11	1	11
2	2	12	2	15	2	12	2	12
3	3	13	3	16	3	13	3	13
4	4	14	4	17	4	14	4	14
5	5	15	5	18	5	15	5	15
6	6 *	16 *	6	19	6	16	6	16
7	7	17	7	20	7	17	7	17
8	8	18	8	21	8	18	8	18
9	9	19	9	22	9	19	9	19
10	10	20	10	23	10	20	10	20
11	1	11	11	24	-	-	21	26
12	2	12	12	25	-	-	22	27
13	3	13	13	26	-	-	23	28
14	4	14	1	14	-	-	24	29
15	5	15	2	15	-	-	25	30
16	6	16	3	16	1	11	1	11
17	7	17	4	17	2	12	2	12
18	8	18	5	18	3	13	3	13
19	9	19	6	19	4	14	4	14
20	10	20	7	20	5	15	5	15
21	-	-	8	21	6	16	6	16
22	-	-	9	22	7	17	7	17
23	-	-	10	23	8	18	8	18
24	-	-	11	24	9	19	9	19
25	-	-	12	25	10	20	10	20

*Applicable also to 10-point distributor switches

Figure 10. Distributor bank-contact assignment.

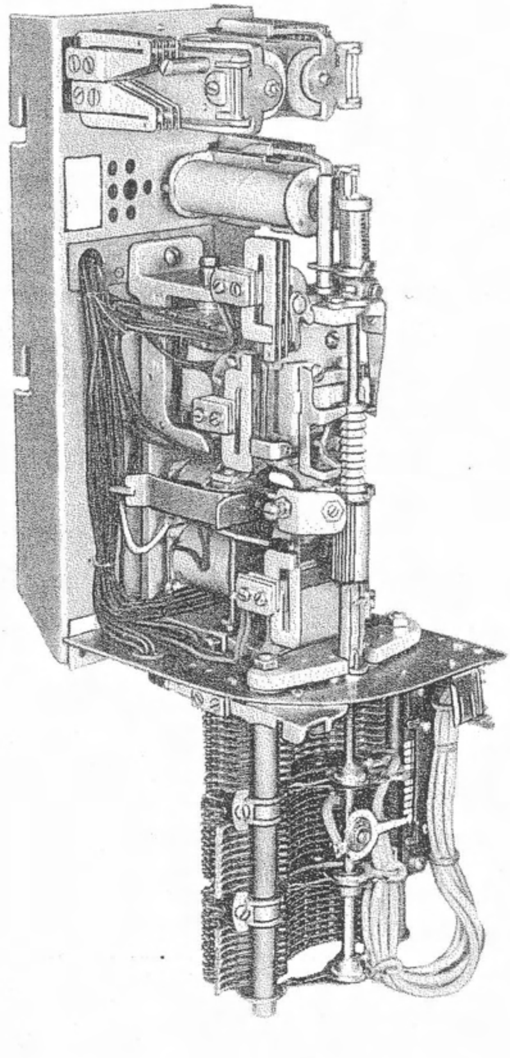


Figure 11. Two-hundred-line linefinder switch.

3.3 Distributor. The distributor switch (figure 9) determines which linefinder will operate next. When activated by the line equipment, the group relays send a "finder start" signal, through the distributor switch, to a preselected linefinder. After the finder has switched the calling line through to the first selector, the group relays step the distributor to the next idle linefinder.

If a switchman busies the linefinder which a distributor has pre-selected, the distributor automatically steps to the next idle finder (see §6.7).

The distributor consists of a 2-level 25-point rotary switch or a 2-level 10-point rotary switch. The group relays step it one step after each call is found; thereafter it steps self-interrupted, seeking absence of ground on the GUARD lead. A pointer and an indicator wheel show on which contacts the wipers are resting. Figure 10 shows to which linefinder each wiper position is connected.

3.4 Linefinders. The linefinder (figure 11) connects the calling line to the associated idle selector. Every line is connected to the contact banks of all the linefinders on its shelf. Each line has a + wire, a - wire, and, within the central office, a control wire. Figure 12 shows their location on the group A and group B linefinder banks. (In the control bank each number represents a metallic contact; each horizontal line, an insulator.) The line contacts for line equipments 00 to 99 are in the lower line bank and the line contacts for line equipments 100 to 199 are in the upper line bank. The control contacts of the 200 lines are in the control bank. Those lines appearing on the lower levels of group A linefinder banks appear on the upper levels of group B linefinder banks (figures 3 and 12) because of the reverse multipling between the groups. The linefinder's vertical wiper (figure 11) touches a different vertical contact after each vertical step. The bottom vertical contact keeps the vertical-bank wiper properly aligned when at its normal position.

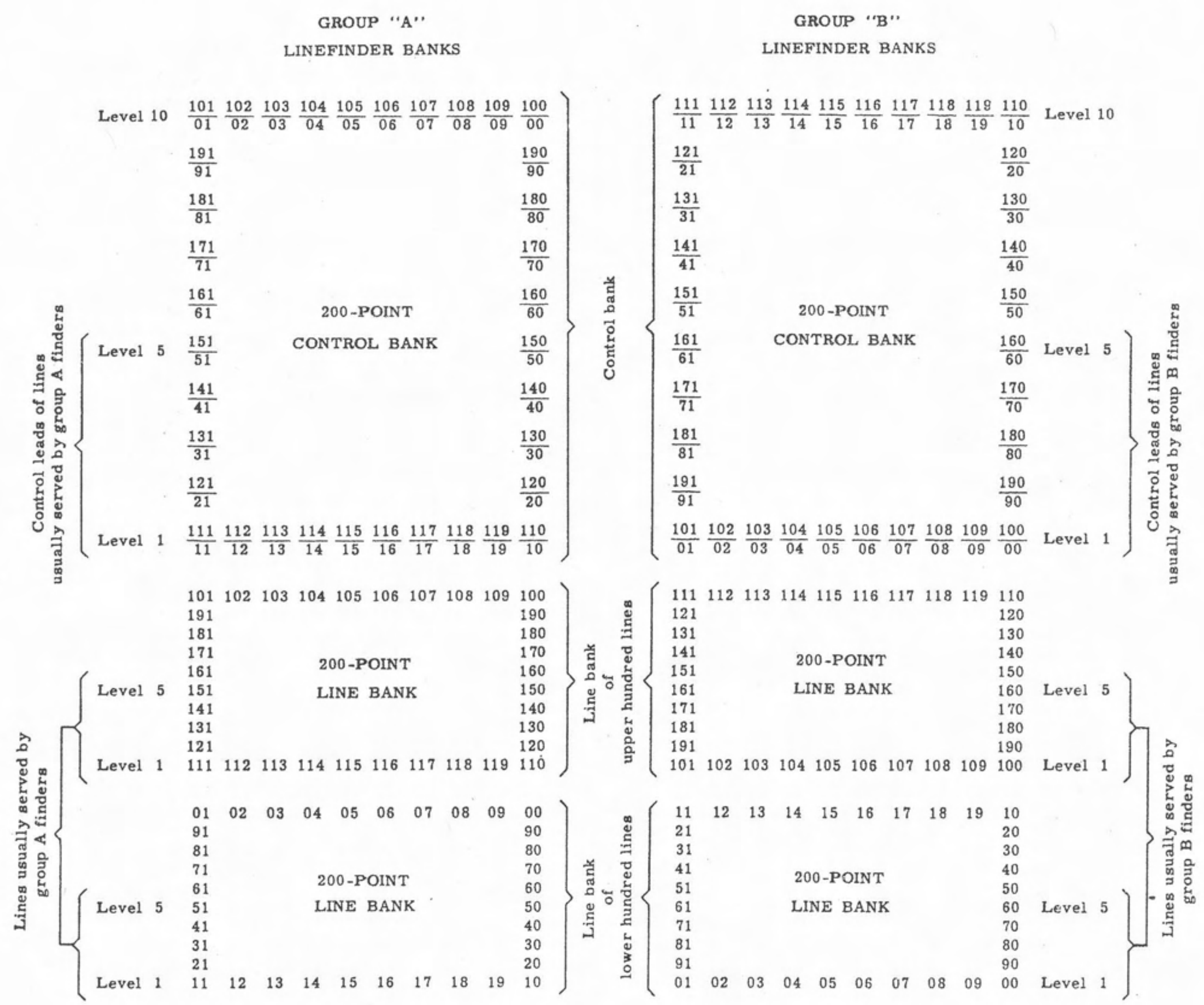


Figure 12. Bank numbering for 200-line linefinders.

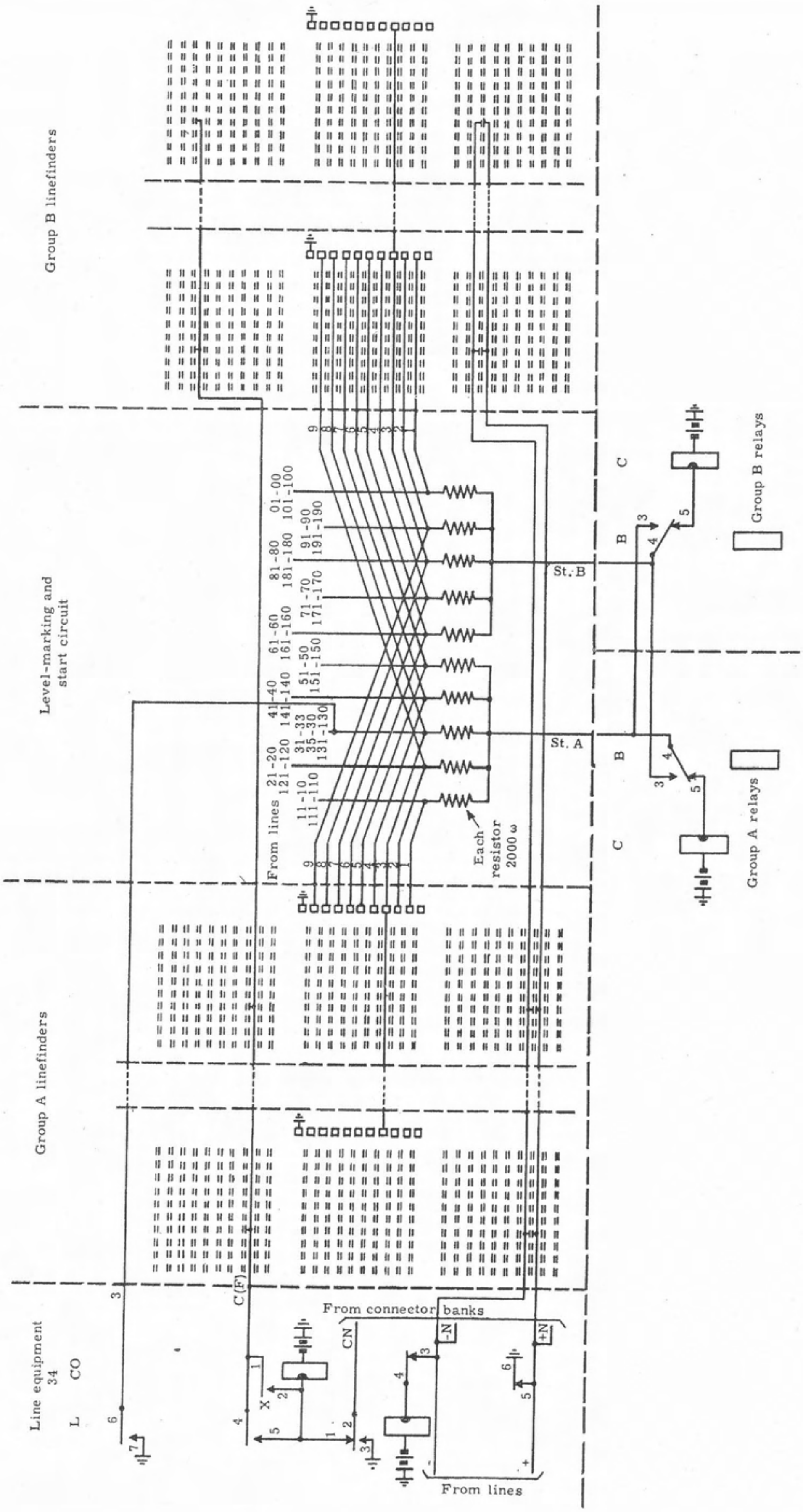


Figure 13. Group-relays seizure.

The wiring between the vertical contacts of group A and group B linefinders is also reversed so that when group A level 3 is marked, group B level 8 also is marked (figure 13).

A typical 200-line linefinder consists of a Strowger switch and three relays mounted on a base plate (figure 11). A metal cover (not shown) protects the assembly from dust and physical injury. The Strowger switch mounts, in addition to those contacts already mentioned, vertical-off-normal contacts (which release mechanically when the shaft and wipers are lifted from their normal position), rotary cam contacts (operating when the shaft and wipers take the eleventh rotary step), and normal-post springs (operating when the linefinder shaft and wipers rise to a level whose lug (figure 14) has been bent*, §6.1, §6.2, and §6.3). The pattern of bent lugs

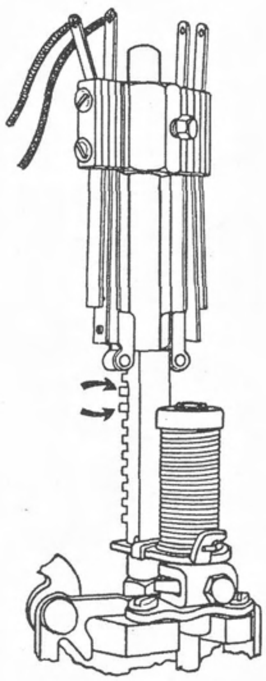


Figure 14. Normal-post springs.
Arrows show cam lugs bent 90° to operate left normal-post springs when wiper-shaft is opposite or cut in on level 2 or 3.

on group A and group B linefinders is reversed since, due to reverse multipling, the subscriber lines appearing on the lower levels of group A linefinder banks appear on the upper levels of group B linefinder banks. At the bottom the switch has (left to right) a busy key (§6.7), a number plate, and a test jack (§6.51 and §6.52). The number plate shows to which selector the linefinder is connected. All connections between the linefinder and the linefinder shelf are made through a jack-in connector called the shelf jack. When the linefinder is removed from the shelf, one pair of shelf-jack contacts close. This grounds the control lead to mark that linefinder unavailable for service.

---

*Cam adjuster H-47202-A is used to bend the cam.

A linefinder seldom need take more than five vertical steps to find a calling line, but when all finders having the calling line on their lower five levels are busy, a linefinder of the other group will step to its upper levels to connect to the line. When all finders are busy, no linefinder finds the calling line, and no dial tone is returned to the subscriber; he must wait until he hears it before he dials.

3.5 Fuse panel. The shelf fuse and lamp panel mounts 3-ampere fuses; 1 for each 20 line circuits, 1 for each 5 linefinders, 1 for each relay group and associated distributor, 1 for meters, and 1 for miscellaneous circuits. The red FA (fuse alarm) lamp will light when any of these fuses blows and remains lighted until the blown fuse is removed. The white ST SIG (start signal) lamp lights, after $\frac{1}{4}$ to 4 minutes, when one or more calling lines are not being served. A white FDR BLOCKED (finder blocked) lamp lights when its associated relay group becomes inoperative and causes the other group's finders to find its lines. The FDR BLOCKED lamp will remain lit until the corresponding non-locking GROUP RESET push button is operated. The white PERM (permanent) lamp lights* when a subscriber whose line equipment is equipped for lock-out fails to dial within two to four minutes after lifting his handset.** The light remains lighted until the lock-out is released. The white LB (lower bank) lamp lights if one presses together the lower test-jack springs of a linefinder connected to a line in its lower bank. The green RLS (release) lamp lights when the circuit of a linefinder release magnet has been closed several seconds without the finder releasing.

3.6 Meters. Linefinder shelves may mount up to four counters (figure 5 shows two). A PCA (peg count, group A) meter counts the calls made through group A linefinders; a PCB meter, through group B linefinders. An ATB (all trunks busy) meter counts the times that all linefinders on the shelf are busy. An OF (overflow) meter counts the number of calls that are not completed because all finders on the shelf are busy.

4. NORMAL OPERATION

The following describes the normal operation of a typical linefinder.

4.1 Marking the calling line. Lifting the subscriber's handset operates his line relay (figure 6, ground through relay CO contacts 6-5, + line, subscriber's telephone, - line, and relay CO contacts 3-4). Relay L grounds connector lead CN to busy the line to other calls, connects the cut-off relay to linefinder bank contact CF to mark the line, and grounds the appropriate level-

---

*Often the PERM lamps throughout the office are commoned to a toggle switch or the like, so that the PERM signals can be cut off except when the maintenance personnel wish to check permanent signals.

**Also, in an office 100% equipped with lock-out, and with reverting-call switches wired not to supply talking battery, the PERM signal lead is grounded throughout a reverting call.

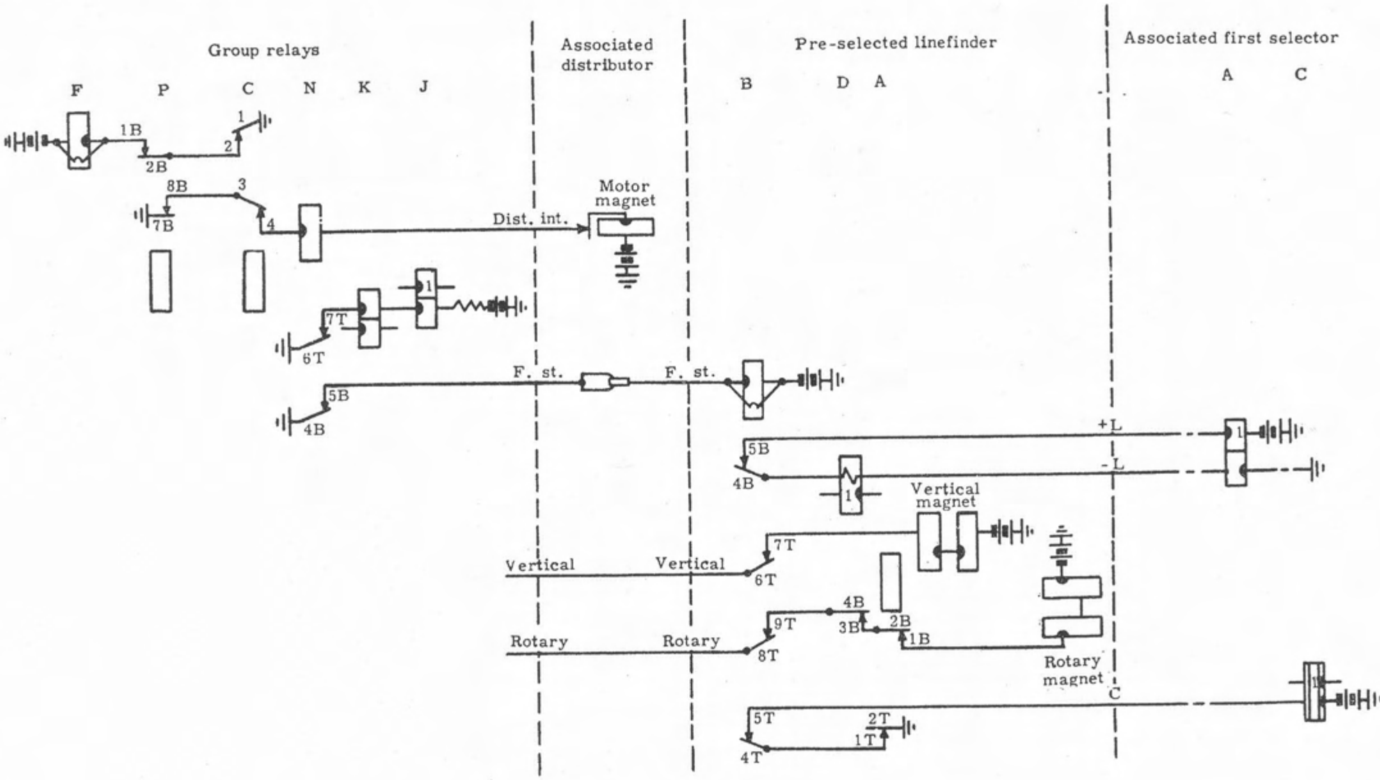


Figure 15. Group relays start the preselected linefinder.

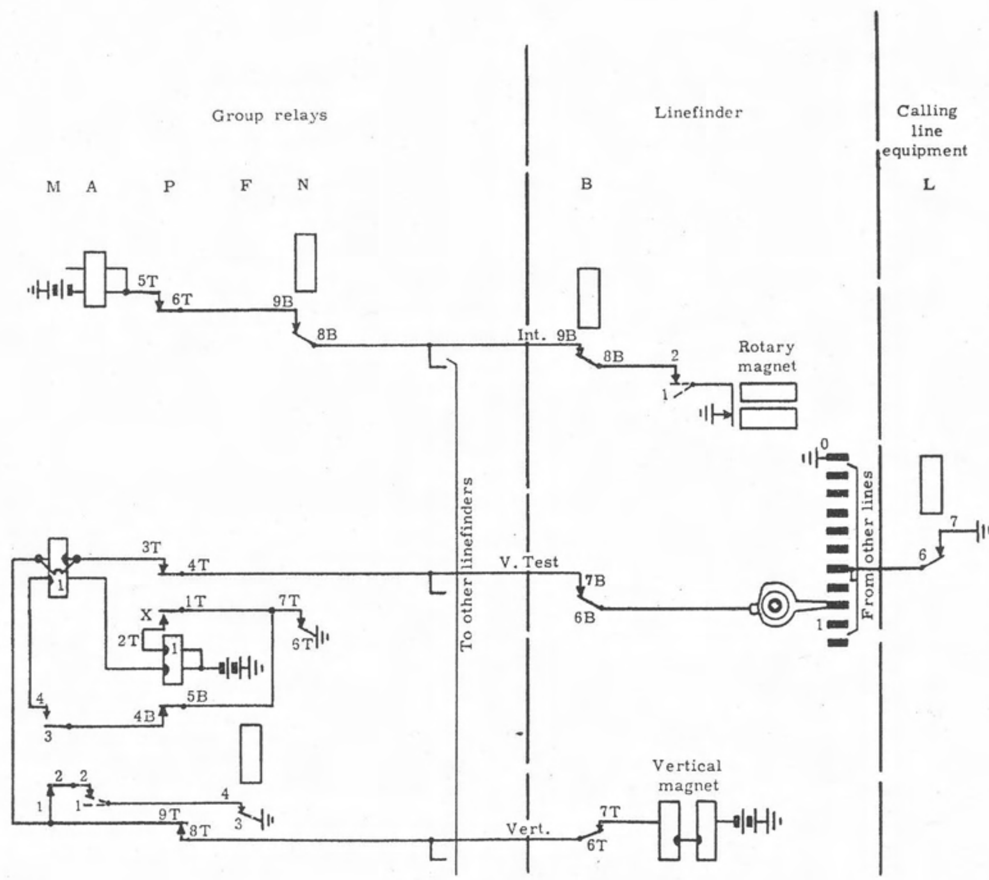


Figure 16. Vertical stepping.

marking and start lead. Ground on the level-marking and start lead marks the vertical contact corresponding to the calling line's level in each linefinder. (Because of reverse multipling (figure 13), different levels are marked on group A and group B linefinders. For example, line 34 marks level 3 of group A linefinders and level 8 of group B linefinders.) The ground on the level-marking and start lead also operates (through a 2000Ω resistor) relay C of the group relays. The 2000Ω resistors (mounted on the rear of the linefinder shelf) restrict direct* ground to the vertical contacts of the calling line's level.

4.2 Starting. The operation of a group's relay C indicates that a linefinder of that group must find the calling line. Relay C operates relay F (figure 15) and connects relay N in series with the distributor motor magnet. Relay N operates (but the distributor motor magnet does not). Relay N closes a circuit through relay K winding 2 and relay J winding 2. Relays K and J do not operate but, being pre-energized, will operate quickly when needed. Also, through the FST (finder start) wiper of the distributor, relay N operates relay B of the preselected linefinder. Linefinder relay B operates associated first-selector relays A and C and connects the preselected linefinder's vertical and rotary magnets to the group relays. Since only the preselected linefinder's vertical and rotary magnets are connected to the group relays, the preselected linefinder is the only one that can be stepped by the group relays.

*The "feedback" ground through 4000Ω on all other vertical-bank contacts is insufficient to stop the finder.

4.3 Vertical stepping. Linefinder relay B also (figure 16) operates group relay A. Group relay A operates the vertical magnet of the preselected linefinder. The vertical magnet lifts the shaft and wipers one step and opens the vertical-interrupter contacts. The vertical-interrupter contacts release group relay A which releases the vertical magnet. Upon releasing, the vertical magnet closes the vertical-interrupter contacts which operate relay A. This cycle repeats until the wipers are lifted opposite the level of contacts containing the calling line. The vertical wiper then touches the marked vertical contact.

As the vertical armature completes its stroke, the vertical-interrupter springs release relay A, removing a short circuit from relay M which operates in series with the vertical magnet (ground through line-relay contacts 7-6, the vertical wiper, linefinder relay B contacts 6B-7B, relay P contacts 4T-3T, relay M, relay P contacts 9T-8T, linefinder relay B contacts 6T-7T, and the vertical magnet). The vertical magnet holds* operated in series with relay M. Ground through relay N contacts 6T-7T, relay P contacts 4B-5B, relay M contacts 3-4, relay M winding 1, and relay P operates relay P. Relay P locks, releases relay M by opening both its windings, releases the vertical magnet, and transfers the pulsing path from vertical to rotary magnet. The vertical magnet, releasing, operates relay A.

*If the vertical magnet fails to hold operated in series with relay M, relay A will reoperate, immediately. However, relay M contacts 1-2 will prevent ground from relay F contacts 3-4 through relay A contacts 1-2 from operating either the vertical or the rotary magnet. In this case, relay M on restoring completes the circuit of the rotary magnet.

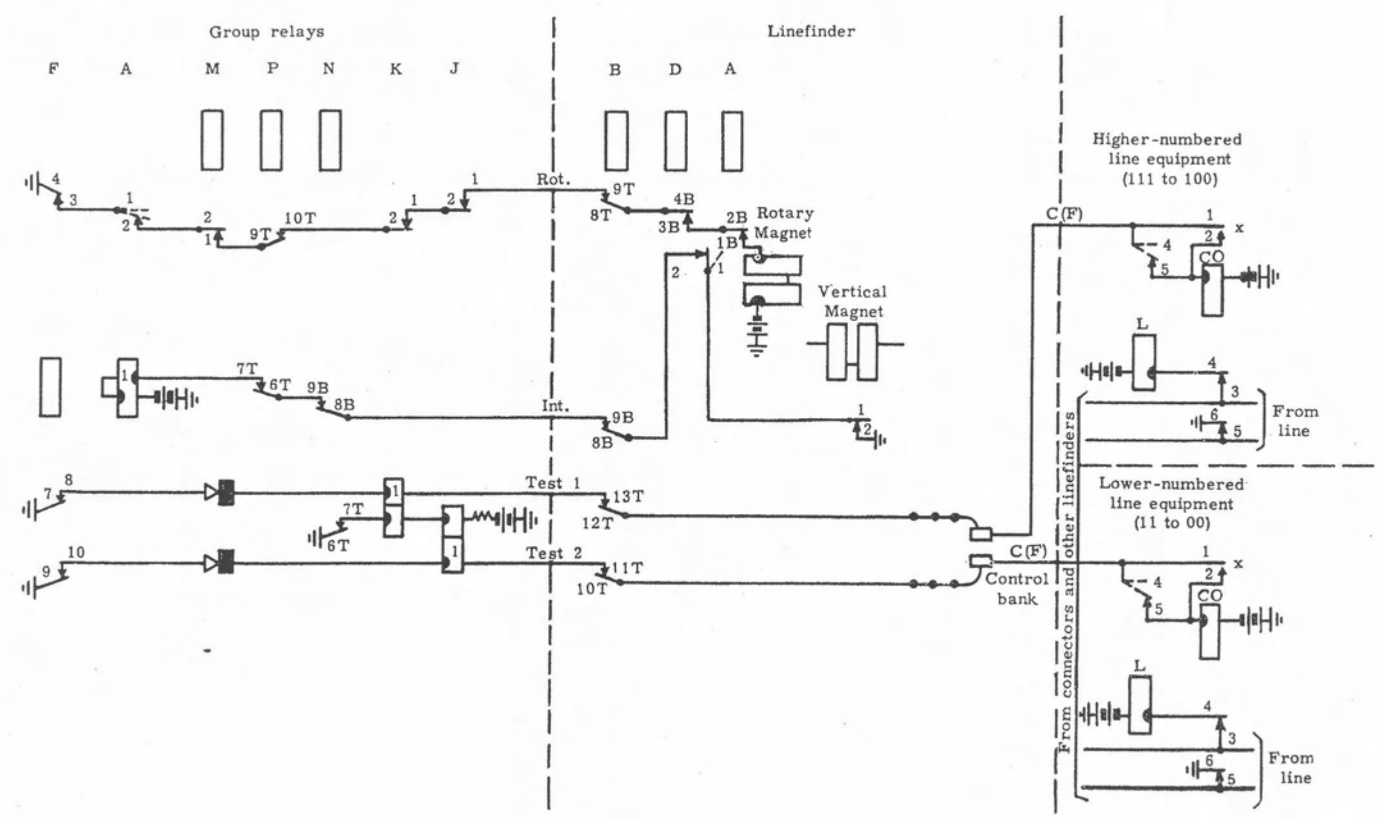


Figure 17. Rotary stepping.

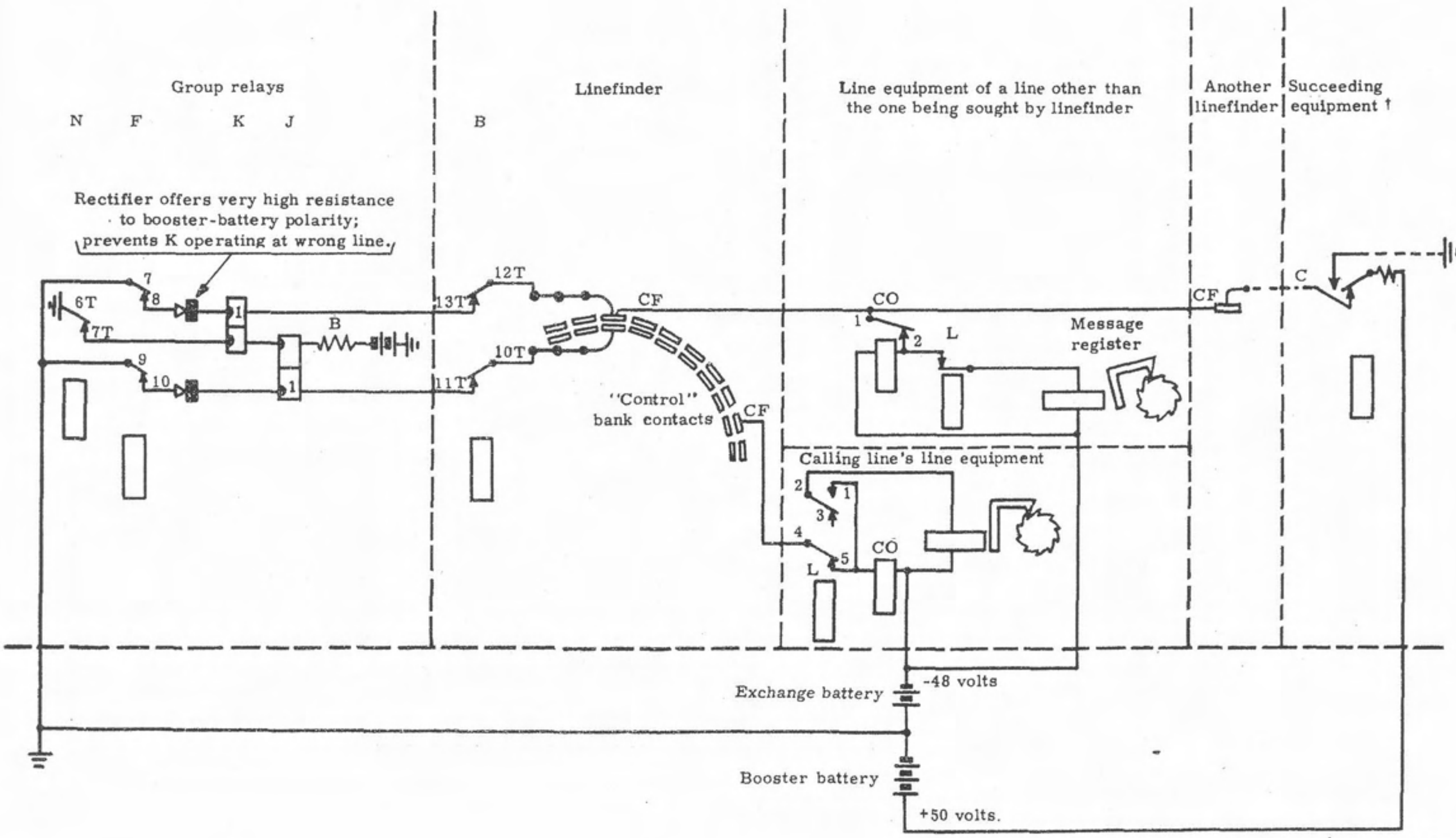
4.4 Rotary stepping. Upon operating, relay A operates the rotary magnet of the linefinder (figure 17). The rotary magnet rotates the shaft and wipers one step and opens the rotary-interrupter contacts. (When the bank-contact wipers rotate, the vertical wiper swings away from the vertical bank.) The rotary-interrupter contacts release group relay A which releases the rotary magnet. Upon releasing, the rotary magnet closes the rotary-interrupter contacts which operate relay A. This cycle is repeated until the control wipers touch the marked control bank contact. If the higher-numbered line is calling, its line relay is operated and its cut-off relay operates in series with relay K. If the lower-numbered line is calling, its line relay is operated and its relay CO operates in series with relay J. Relay J or K opens the circuit to the rotary magnet to prevent further rotary stepping. Relay CO locks and removes the line relay from across the subscriber's line. Upon releasing, relay L removes ground from its level-marking and start lead (figure 13).

4.41 Need for rectifiers. In an exchange where billings are based on the number of calls made, provision must be made so that completed calls (only) are recorded. This is done with meters which will not operate on the exchange voltage (48 volts) but will operate on 98 volts. A booster battery of 50 volts and the exchange battery of 48 volts in series are used (figure 18). When the called party answers, his battery-feed relay operates and reverses* the polarity on the calling line. This battery reversal triggers a relay group which momentarily replaces the + ground on the C lead with + booster battery. The calling line's meter is operated.

It is possible that a linefinder control wiper, as it hunts across a level of control contacts, will touch one with booster battery on it (figure 18). Then, if nothing had been done to prevent it, current would flow from + 50 volts on linefinder control contact, linefinder control wiper and relay B contacts, group relay J or K and group relay F contacts to ground, and would operate relay J or K falsely and cause the linefinder to switch through into the conversation of another line.

The rectifiers in the relays J and K circuits prevent this by blocking current attempting to flow from + booster battery to ground. The linefinder will then rotate to the calling line's contacts. The rectifiers allow current to flow in the other direction (from ground through relay F contacts, a rectifier, relay K or J, linefinder relay B contacts, a linefinder control wiper, a line's control bank contact, the calling line's relay L contacts, the cut-off relay, to -48 volts) and operate relay J or K.

*If called party does not answer there will be no reversal.



† The "succeeding equipment" may be a trunk circuit between the linefinder and the first selector, or it may be part of the connector.

Figure 18. Use of and need for rectifiers.

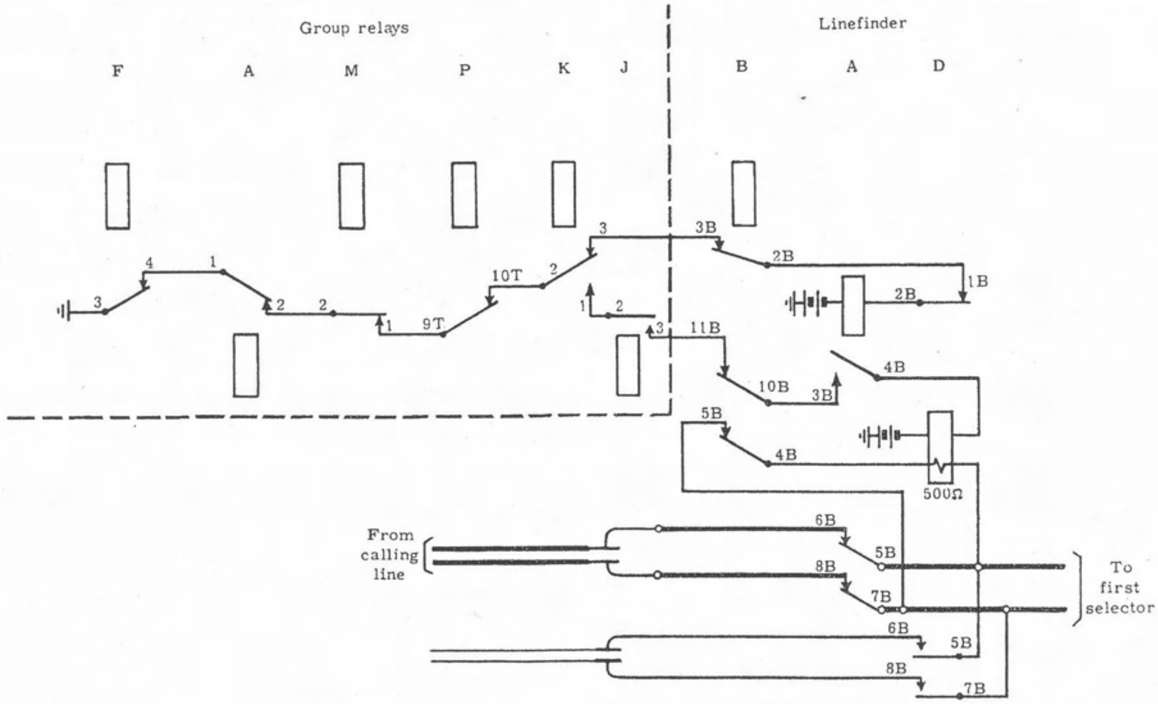


Figure 19. Linefinder extends caller through to pre-seized first selector. (Upper-bank line shown as example.)

4.5 Extending calling line to selector. If the higher-numbered line is calling, group relay K operates, operating finder relay A. Relay A locks and extends the calling line to the first selector. If the lower-numbered line is calling, group relay J operates, operating finder relay D. Relay D locks and extends the lower-numbered line to the first selector. (In case both lines are marked when the two control wipers step onto them, both relays J and K will operate. Relay K will open the circuit to linefinder relay D so only relay A can operate (figure 19). The linefinder will therefore extend the higher-numbered line to the first selector, and the next selected linefinder will serve the lower-numbered line.) Dial tone from the first selector notifies the subscriber to commence dialing (figure 20). Ground from selector relay B now holds the linefinder relay A or D and cut-off relay CO operated. This ground is also on lead CN to keep the calling line marked busy at the connector banks.

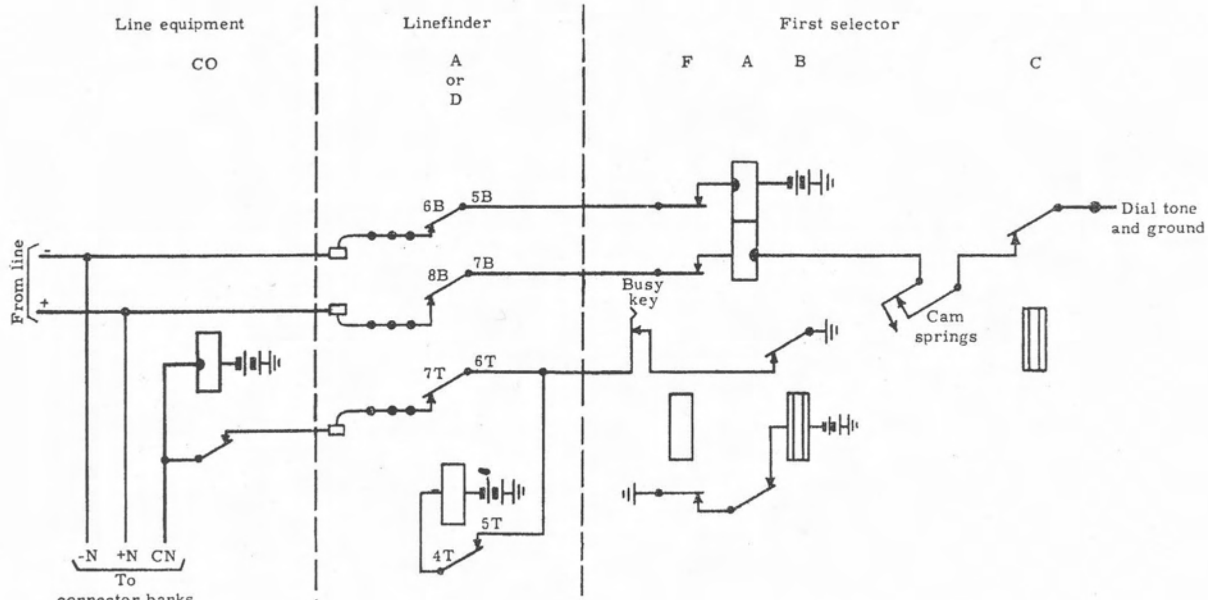


Figure 20. First selector holds the cut-off relay and the linefinder, and supplies dial tone.

4.6 Stepping distributor to next idle finder. The operation of relay A or D (figure 21) places ground on the linefinder G (guard) lead, operates the motor magnet of the distributor and short-circuits relay N, making N slow to release. Upon releasing, relay N releases group relays A and F (figure 17) and linefinder relay B, and steps the distributor by opening the circuit of its motor magnet. Relay F releases relays P and J or K. The distributor wipers now are on the contacts for the next linefinder. If this linefinder is busy, ground on its lead G through group relay N contacts 2B-1B, group relay B contacts 8-9, distributor interrupter springs, and motor magnet operating the motor magnet which operates the interrupter springs and opens its own circuit, and the distributor steps. This cycle will continue until the distributor rests on contacts leading to an idle linefinder. When another line calls, this newly assigned linefinder will find it and extend it to a first selector. Should a line call while the distributor is searching for an idle finder, group relay C will be operated but group relay N cannot operate until the distributor finds an idle linefinder.

4.7 Releasing. Upon hearing dial tone, the subscriber dials to establish his connection. After the conversation is concluded, connector (or inter-office pulse repeater) relay B releases, removing ground from lead C which releases the selector(s), finder relay A or D (figure 20), and the calling line's cut-off relay, and removes ground from line lead CN to allow the line to receive incoming calls. The cut-off relay reconnects the line relay across the line. Finder relay A or D operates the linefinder release magnet and group relay G in series (figure 48). The shaft and wipers rotate leftward and drop to their normal position causing the vertical off-normal contacts to open the release magnet, and to remove ground from this linefinder's lead G so the group relays can seize the linefinder again when needed.

5. SPECIAL OPERATIONS

5.1 Linefinder does not find vertical marking. If the calling party hangs up just after the linefinder starts, the calling line's vertical contact will not be marked. If there are idle finders in both groups* and the linefinder is hunting a line in its lower levels, it will step to the fifth level where ground on the fifth vertical contact (from its group's relay F, figure 22) will stop its vertical stepping. This ground also prevents the group relay C from restoring when the line relay L is restored. The finder will rotate to the eleventh rotary step and release (§5.2).

5.2 Linefinder does not find rotary marking. If the calling party hangs up either before the linefinder finds his level (§5.1) or just after the linefinder cuts in on the calling line's level, no calling-line bank control contact on the level is marked with negative stopping battery. The linefinder then steps around to the eleventh rotary step where its cam springs operate

*In the event that one group is busy relay B in restoring will prevent ground, from contacts of group relay F of the not-busy group, appearing on the fifth vertical contact of the not-busy group. In this case, when line relay L restores, group relay C restores and restores group relays F and N which restores linefinder relay B. Linefinder relay B in restoring grounds lead G and steps the distributor.

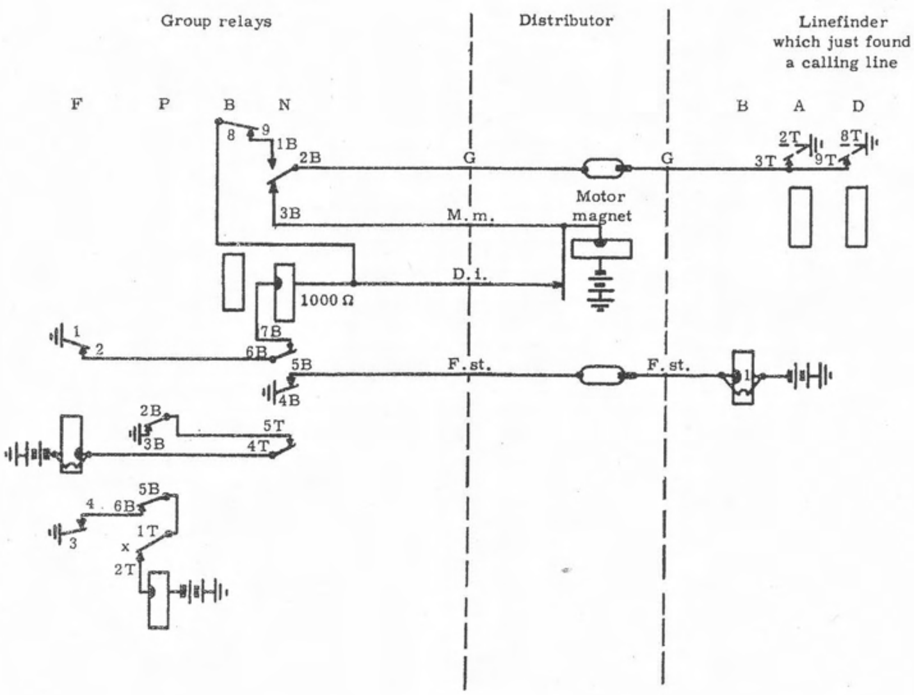


Figure 21. Stepping distributor to next idle finder.

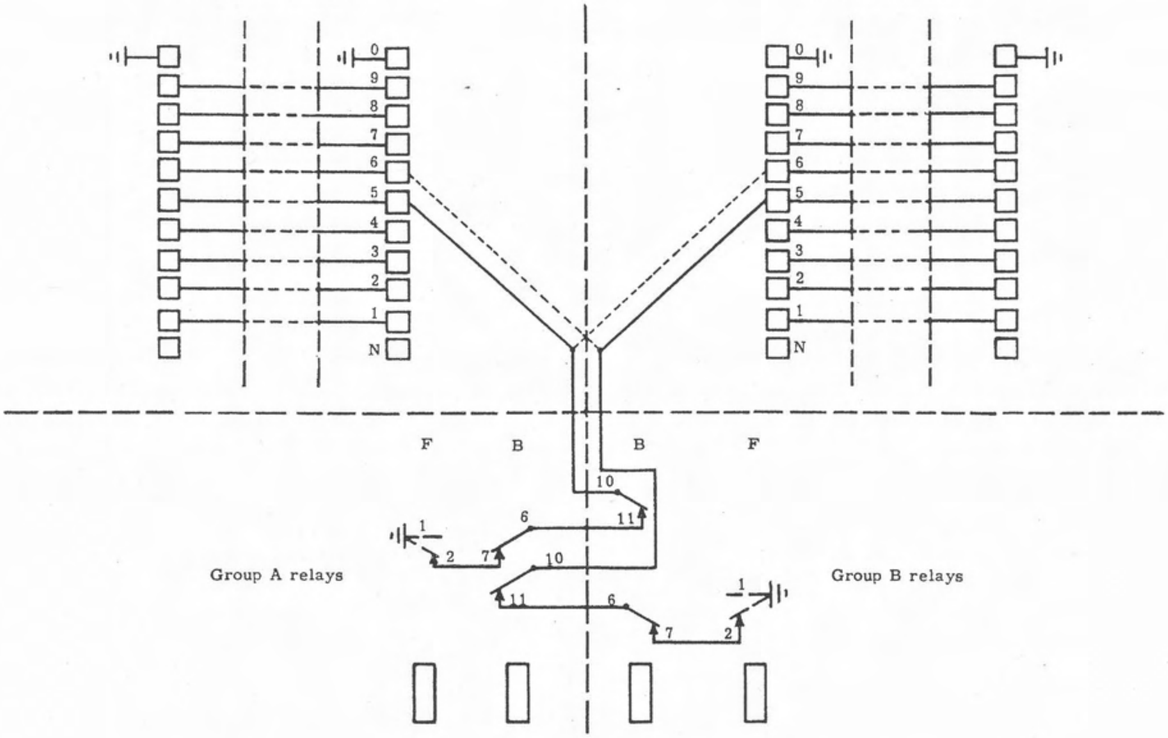


Figure 22. Call abandoned before linefinder reached level containing caller's line — vertical stopping.

relay K (figure 23) which operates linefinder relay A (figure 19) and opens the rotary magnet's circuit to prevent further rotary stepping. Relay A operates the distributor's motor magnet (figure 21) which steps the distributor to the next linefinder. The distributor's interrupter contacts release relay N which releases group relays F and P and finder relay B. Because there is no calling-line loop to hold selector relay A, the release of finder relay B (figure 20) releases selector relay A. First-selector relay B releases finder relay A which operates group relay G (figure 48) and the linefinder release magnet in series. The shaft and wipers, upon returning to normal, open the vertical off-normal contacts which release relay G and the release magnet. (If the calling line's control lead was unmarked due to a circuit fault, the next idle linefinder will hunt for the calling line.)

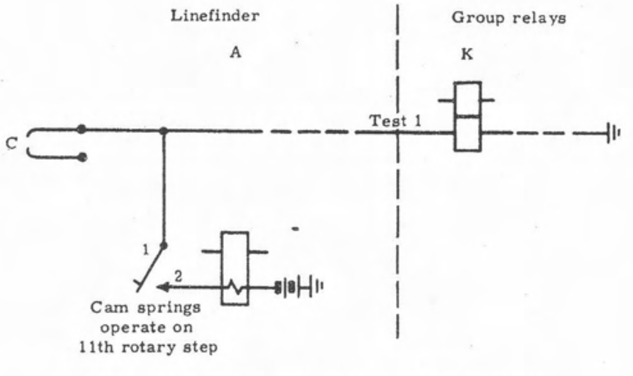


Figure 23. Call abandoned before linefinder reached caller's line — rotary stopping.

5.3 All linefinders of one group are busy. A group's relay B (figure 24) is held operated by ground through relay A contacts of the group's idle finders (and, if a finder is hunting, by ground through group relay N contacts). After the last idle finder of a group becomes busy, group relay N restores, steps the distributor, and removes the last ground holding group relay B. Group relay B releases, disconnects its distributor's motor magnet (figure 21) from the distributor guard wiper so the distributor won't hunt an idle finder when there is none, breaks (figure 22) the path by which the other group relays might ground the other group's level 5, and (figure 24) transfers the START A lead from the busy group's relay C to the not-busy group's relay C. Then any calling line of the busy group will operate the other group's relay C causing a linefinder of the other group to find the line in its upper levels.

5.4 All linefinders of shelf busy. When all finders in both groups are busy, both relays B are released and neither relay C may be operated to start a linefinder. If meanwhile a subscriber attempts to call, upon hearing no dial tone, he will either wait until he receives it or hang up. As soon as any finder becomes idle and restores, it will cause its group relay B to operate, and if a call is waiting will immediately search for it.

5.5 Linefinder fails to cut in. Operating during a linefinder's hunting action, group relay F grounds the start lead of a timer circuit (usually located on the powerboard or the power shelf). If the linefinder wipers are badly out of alignment, they may jam into the bank

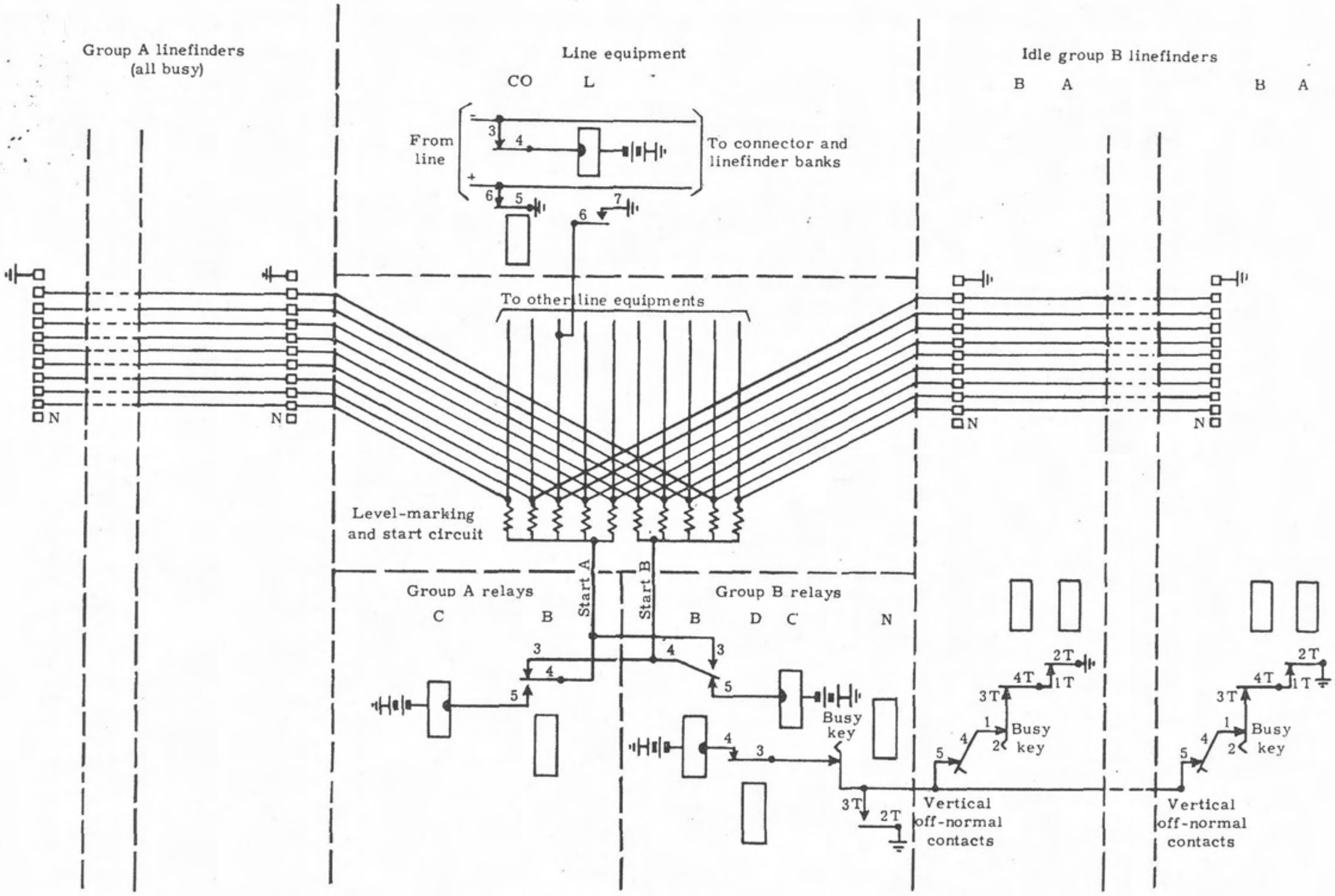


Figure 24. All linefinders of one group are busy.
(In this example, all group A finders are assumed to be busy.)

contacts when the linefinder starts its rotary stepping. Since the linefinder cannot step to the right, the calling line is not switched through to the first selector. Then relay F, usually operated less than a second, is operated continuously. In this case, the timer circuit will, within two minutes, temporarily ground lead TIME 1 operating relay E (figure 25). Two minutes later, a short ground pulse on lead TIME 2 will operate relay D. Relay D will release relays N and B and operate relay L and the motor magnet which steps the distributor to the next finder. Relay L lights the group FINDER BLOCKED alarm lamp. Relay B releases relay C which releases all operated relays but relays D and L. If all linefinders of the other group are busy, relay D will release as soon as ground is removed from lead TIME 2, relays B and C will reoperate, and the waiting call will be sought by another finder of its own group. If some linefinders of the other group are idle, relay D will lock, the waiting call will be found by a linefinder of the other group, and relay D of the inoperative group will be held operated until all finders in the other group become busy or until released manually by operation of the BUSY or TRANSFER RESET key. Operation of the TRANSFER RESET key releases relay L and extinguishes the FINDER BLOCKED alarm lamp.

6. CIRCUIT FEATURES

Sections 6.1 to 6.4 describe optional features that may be supplied on linefinder shelves if the customer so desires. Sections 6.5 to 6.8 describe features of all linefinder shelves. (See also §4.41 re message rate.)

6.1 Restricted service. When a linefinder shelf serves both regular and restricted-service subscribers, the restricted-service subscribers must be segregated in certain levels of the linefinder and regular subscribers must not be connected to these levels.

A linefinder may prevent subscribers on any level* from calling certain trunks. All such linefinder levels and all the denied selector levels must have their corresponding normal-post lugs bent. While connected to any line in the restricted level, the linefinder operates its normal-post springs (figure 26). If the subscriber dials a restricted trunk, the selector will rise to that level and operate its normal-post springs. Ground

*The linefinder can be arranged to restrict service to lines in its upper bank, only. In that case, the ground for the linefinder normal-post springs comes through linefinder relay A contacts (as in the left-hand part of figure 27), and therefore can ground lead EC only when the call originates in the upper-bank lines.

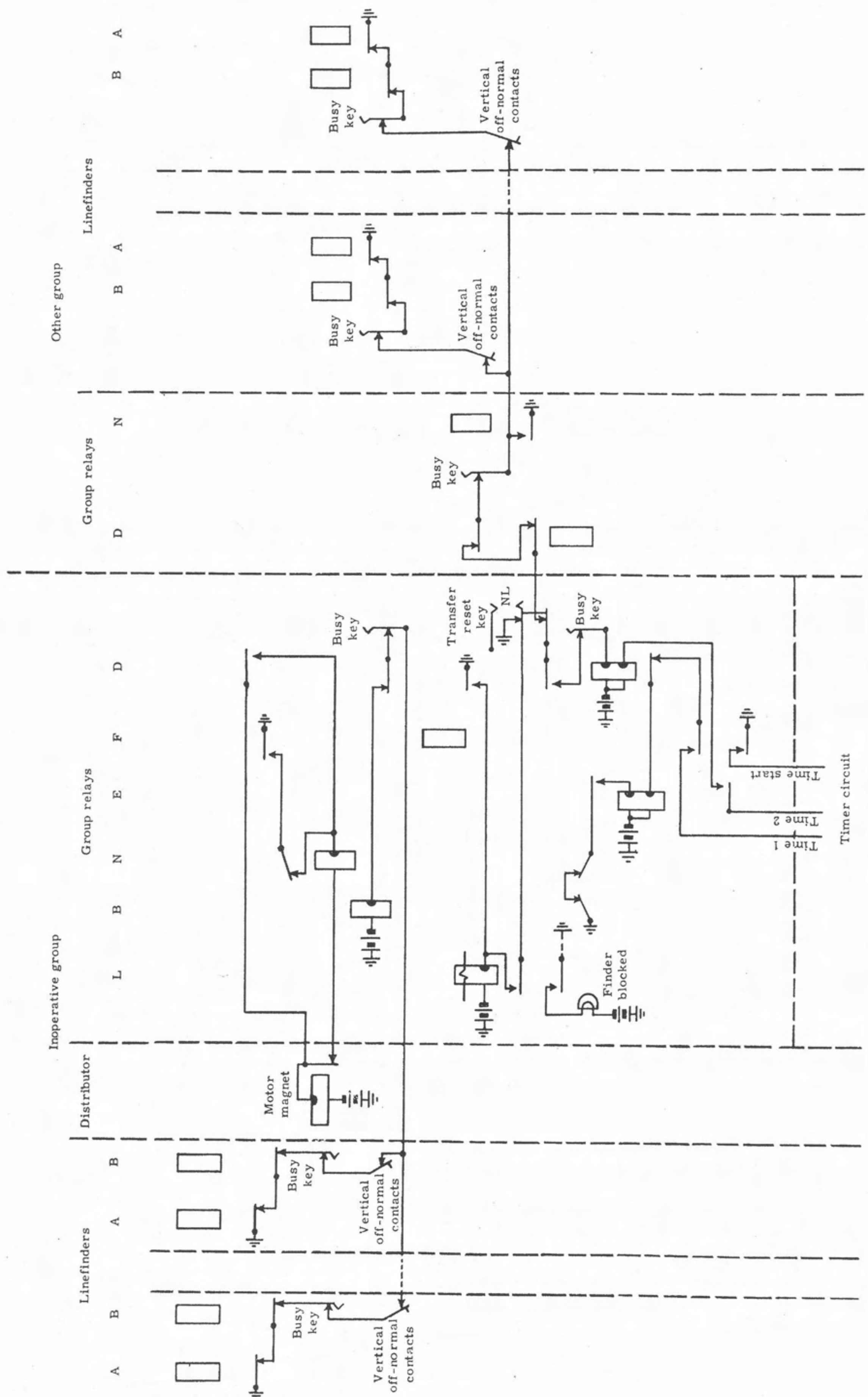


Figure 25. Circuits which "time out" a faulty linefinder or group relays, light the FINDER BLOCKED lamp, and release group relay B (which [figures 13 and 24] transfers traffic to other group).

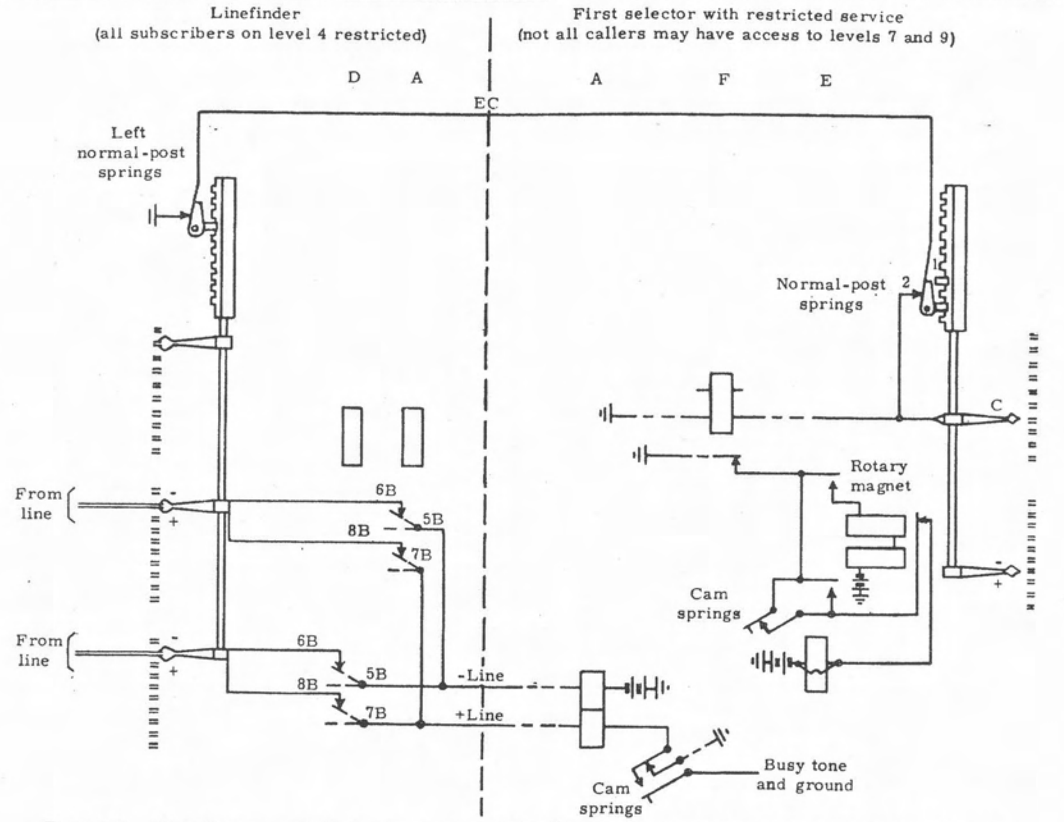


Figure 26. All callers on a linefinder level are restricted from calling certain levels of succeeding selector.

through both normal-post springs grounds selector wiper C and short circuits selector relay F. Relay F short-circuited (grounded on both sides), cannot operate to open the self-interrupting circuit of the selector rotary magnet. The selector rotates to the eleventh rotary step and operates its cam springs which open the stepping circuit of the rotary magnet and return busy tone to the calling subscriber.

6.2 Conversation timing. Unless the conversations of all subscribers are to be timed, subscribers whose conversations are to be timed must be segregated in certain levels of the linefinders, and other subscribers must not be connected to these levels.

Any level of the linefinder upper bank* may have its lines' conversations timed. All such levels must have their normal-post lugs bent. When the linefinder finds one of the ten lines on such a level, the normal-post contacts will operate. Control-lead C ground from relay B contacts, linefinder relay A contacts, and the normal-post springs will ground lead EC (figure 27), notifying the selector that the conversation must be timed.

Typical operation-sequence thereafter is: from 6 to 8 minutes after the called party answers, the selector sends a splash of dial tone to both parties, warning them that they soon will be disconnected. One-half minute later, the warning tone is repeated, and selector relay F restores, removing ground from lead C. The linefinder restores, releasing connector relays A and B which release the rest of the switch train.

---

*The linefinder can be wired for conversation timing in both banks of any level. In that case, the linefinder normal-post springs always have ground available (as in the left-hand part of figure 26).

6.3 Class-of-service indication. In Strowger Automatic Toll Ticketing installations, the linefinder normal-post springs are wired to identify each level's class of service. This class-of-service indication determines the routing of a call (e.g., direct*, via ticketer**, or via operator***) and causes the toll ticketer, if used, to compute each line's bill in accordance with its class of service.

The 20 lines on any linefinder level (i.e., the 10 upper-bank lines and the 10 lower-bank lines) must all be of one and the same class of service.

A single linefinder shelf can accommodate only class 1, 2, and 3 subscribers or class 4, 5, and 6 subscribers.

6.4 Permanent timing and line lock-out. A "permanent" line is one whose line equipment is operated accidentally (due to a handset improperly placed in its cradle, leakage across the loop, grounded negative line, etc.). The operated line equipment causes a linefinder to connect to the line. As this ties up a linefinder and a first selector needlessly, a line circuit with a "lock-out" feature is sometimes used. If the line does not dial within two to four minutes, the first selector releases the linefinder, and the line equipment "locks out" so as not to seize another finder-selector link. Two common "lock-out" circuits are the three-relay "lock-out" circuit (figure 28) and the two-relay mechanical "lock-out" circuit (figure 31).

---

*For extended-rate subscribers in some cases, or for all subscribers when calling non-toll numbers.
**For ordinary subscribers calling A-B-toll destinations.
***For paystation customers calling A-B-toll destinations.

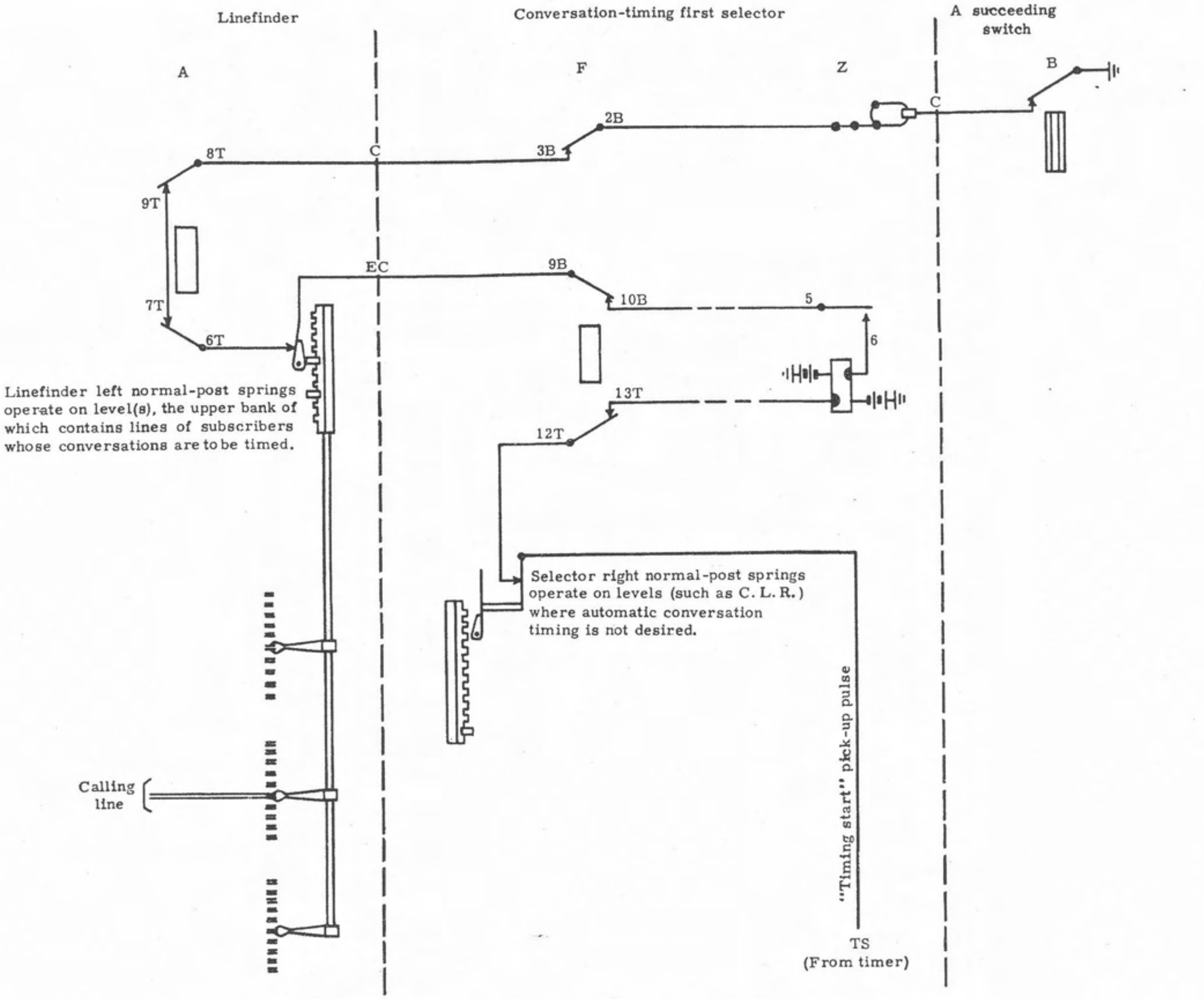


Figure 27. Upper-bank subscriber lines on certain levels (levels 5 and 8 in this example) will have holding-times or conversations timed.

6.41 The three-relay lock-out line circuit (figure 28) operates as follows on an outgoing call. When the subscriber lifts his handset, current through his telephone operates the line relay. The line relay grounds connector control lead CN to busy the line to other calls, connects the cut-off relay to the linefinder control lead to mark the calling line's contacts on the linefinder banks, and grounds the level-marking and start lead to start the linefinder. The linefinder, connecting to the line, grounds lead C, operating cut-off relay CO. Relay CO locks, removes the line relay from across the line, and operates lock-out relay LO.

If the subscriber does not dial within two to four minutes, the first selector removes ground from lead C. Relay CO restores, grounds the lead to the PERMANENT lamp on the linefinder shelf, places the line relay across the line again, and opens the circuit of relay LO. Relay LO, being slow to release, remains operated while the line relay operates again from current through

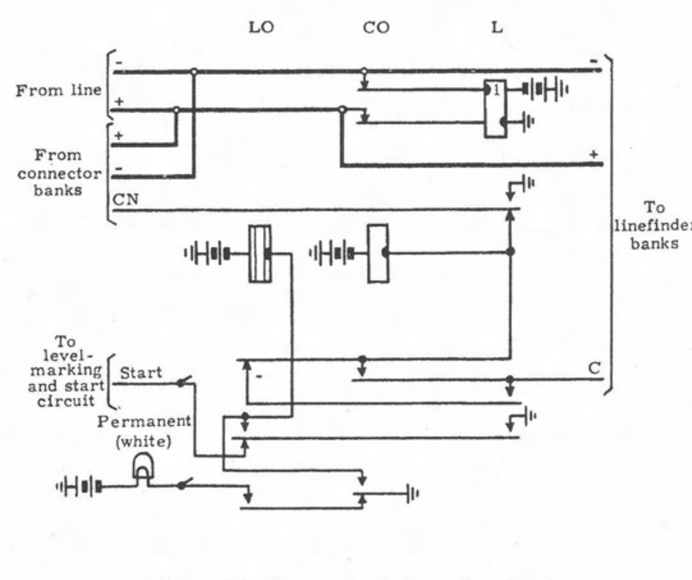


Figure 28. Three-relay lock-out line circuit.

the subscriber's telephone. The lock-out relay, held now by the line relay, prevents ground from being placed on the start lead even though the line relay is operated, and keeps stopping battery (through relay CO) from reaching the finder control banks. Relay L grounds lead CN to mark the line busy.

When the permanent is removed, relay L restores, and releases relay LO. The circuit is normal again.

On calls to the subscriber, ground from connector lead CN operates relay CO which removes the line relay from across the line and operates relay LO. If the central office has calling-party-release connectors, on calls where the calling party hangs up first, the called line equipment will lock out until the called party hangs up.

6.42 The mechanical lock-out line equipment consists of two relays mechanically interlocked (figure 29). An extension of the line relay inner armature spring (1) transmits the armature motion to the outer two spring combinations. A crank disengages this extension from

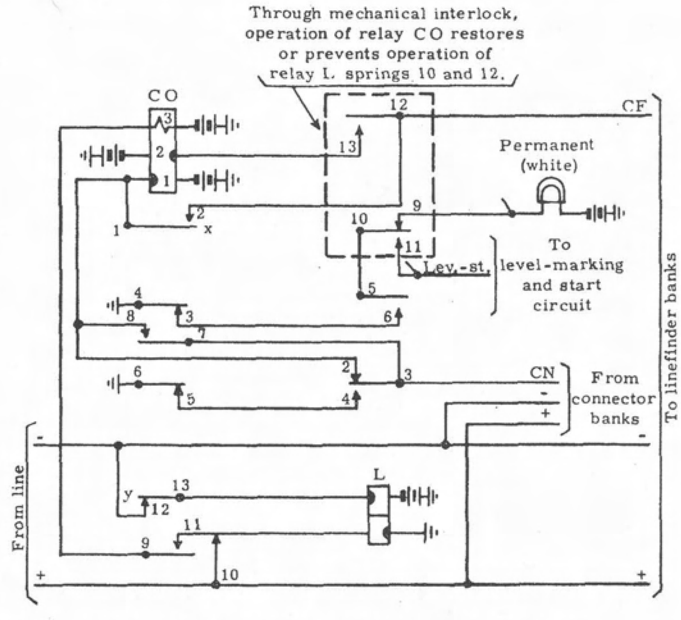


Figure 31. Two-relay mechanical-lockout line circuit. Normal.

When a subscriber lifts his handset to make an outgoing call (figure 32), he operates the line relay which grounds connector control lead CN to busy the line to other calls, connects winding 2 of the cut-off relay to lead CF to

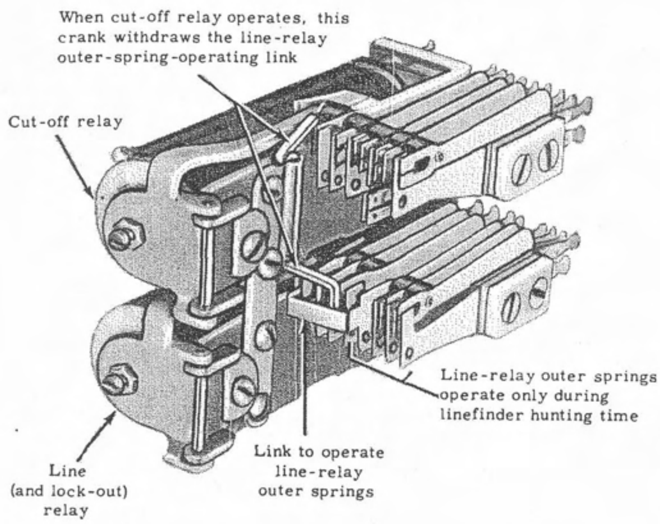


Figure 29. Mechanically interlocked line and cut-off relays for 2-relay mechanical-lockout line circuit.

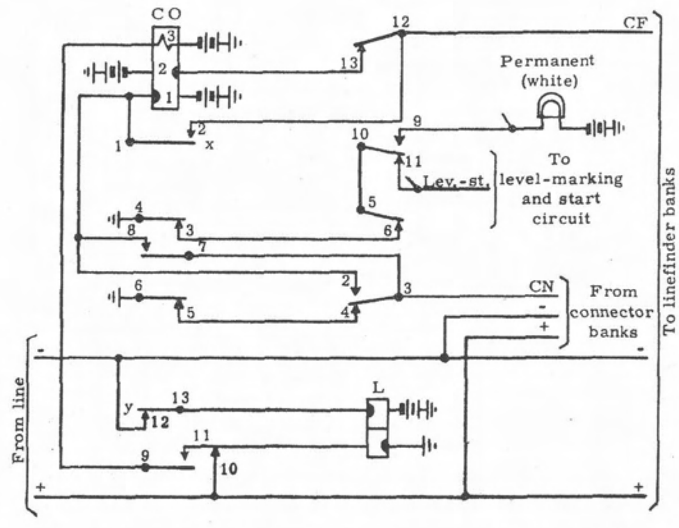


Figure 32. Two-relay mechanical-lockout line circuit. Calling line being sought by linefinder.

the outer spring combinations when the cut-off relay operates. Thus the line-relay outer spring combinations (figure 30 rignt-hand springs 10 and 12) are released when the cut-off relay is operated.

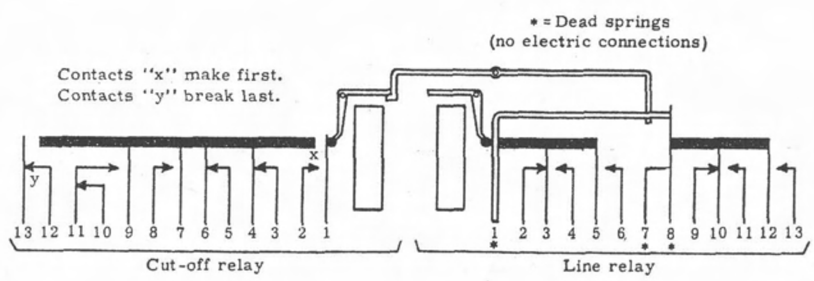


Figure 30. Diagramatic representation of mechanical interlocks, etc., of the lock-out line-circuit relays depicted in figure 29.

mark the line's contacts on the linefinder banks, and grounds the level-marking and start lead to start the linefinder. The linefinder, upon connecting to the calling line (figure 33), grounds control lead CF operating the cut-off relay. The cut-off relay locks, keeps the line relay operated from battery through its winding 3, removes the line relay from across the line, removes ground from the level-marking and start lead, and moves the interlock crank so that the line relay's outer spring combinations release and remove ground from the start lead.

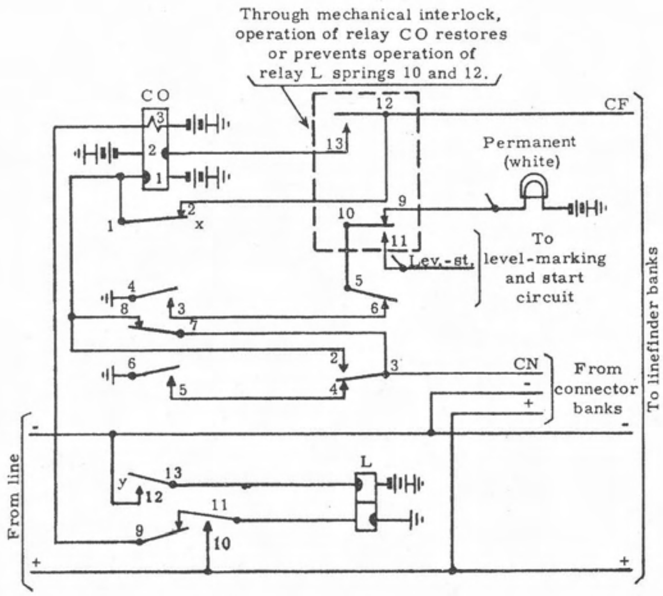


Figure 33. Two-relay mechanical-lockout line circuit.
Linefinder has found calling line.
Circuit conditions are the same also on a call to the line.

If the calling party does not dial within two to four minutes, the first selector removes ground from lead C. Relay CO releases (figure 34), lights the PERMANENT lamp, and places the line relay across the line—which keeps the line relay operated until the permanent is cleared.

On calls to the subscriber (figure 33), ground on connector control lead CN operates relay CO which removes the line relay from across the line to improve the transmission circuit and operates the line relay (inner springs only). On calls to the subscriber, the lock-out feature comes into play only if the central office uses calling-party-release connectors.

6.43 "100% lock out". If all lines of a central office are equipped with lock-out type line circuits, connectors should be wired for calling-party release, and reverting-call switches (§6.431) should be wired not to supply talking battery.

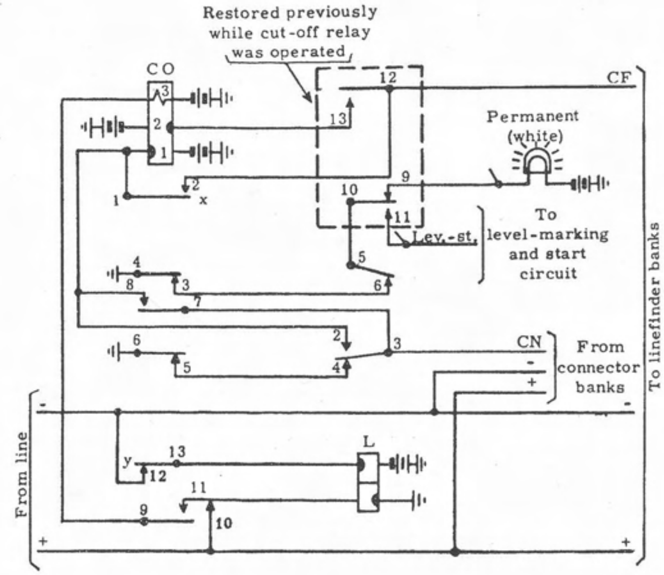


Figure 34. Two-relay mechanical-lockout line circuit.
Line "locked out."
These are the circuit conditions, for example: on a reverting call, with line equipment supplying talking battery; an unduly long conversation timed out; "permanent" timed out; or, with calling-party-release connectors, when the caller has hung up but the called party has not.

6.431 Reverting calls. If all lines of a central office are equipped with lock-out type line circuits the reverting-call switches are wired to remove ground from the control lead when* the called party answers. The selector(s) and the line-equipment cut-off relay release. The line equipment goes into "lock out" for the duration of the conversation; the line relay supplies talking battery. If not turned off, the PERMANENT lamp is lighted throughout the conversation, of course.

When the reverting call is concluded, the line equipment releases.

6.5 Testing.

6.51 Tracing a call or a "permanent" (figure 35). If a 200-line linefinder is connected to a line in its lower bank, its relay D is operated (§4.5), and if a switchman presses together linefinder test-jack springs 10 and 11, the linefinder-shelf LOWER BANK lamp lights. If the linefinder is connected to an upper-bank line, relay D is not operated and when test-jack springs 10 and 11 are pressed together the LOWER BANK lamp will not light.

6.52 Monitoring. If a test phone is inserted between test-jack springs 8 and 9 (figure 48) of an operated linefinder, the conversation through that finder may be monitored.

---

*Many reverting-call switches send "tick tone" on the line for a few seconds after the called party answers (to keep the called party on the line until the caller returns to the line), and thereafter release the selector(s) and linefinder.

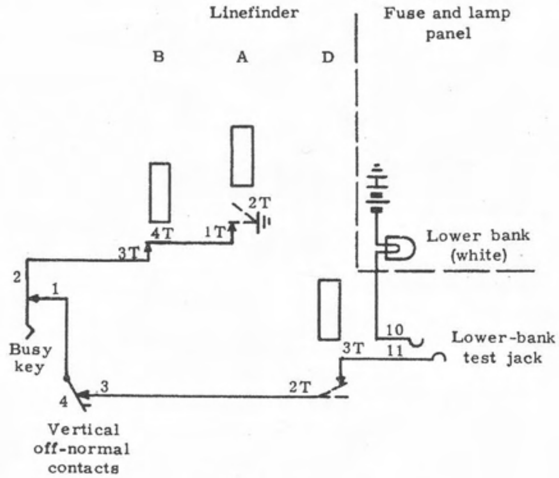


Figure 35. Circuit for lower-bank test to determine which wipers of a 200-line linefinder are in use.

6.53 "Cascading" test (figure 36). If group relay test-jack springs 1 and 2 are connected together, that group's relay C operates and starts a linefinder. Since none of the contacts in that finder's bank are marked, the finder will step to the fifth level, rotate to the eleventh step, advance the distributor, and release. The next linefinder will repeat this, and so on. This "cascading" permits a rapid check of the vertical and rotary operations of all finders as they operate in rapid succession.

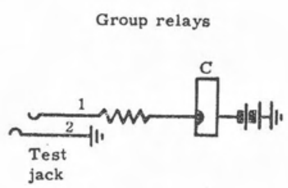


Figure 36. "Cascading" test.

6.54 Test lines. Insertion of a test phone ("butt-in") in group-relay test-jack (figure 48) springs 5 and 6 (or bridging the jacks in any way) operates the line relay of the test line equipment (usually line 29 (group A) or line 199 (group B)) which causes the preselected linefinder to find that line. This checks that the linefinder hunts properly and that the selector returns dial tone properly. Dial to check whether the selector steps, rotates, and removes dial tone properly.

6.55 Timing-out and transfer test (figure 37). To check the group transfer feature of a group, insert a coin, clip, or screwdriver between its test-jack springs 3 and 4. Then bridge or press together group-relays test-jack springs 1 and 2. Relay A locks when the shaft takes its first step. Since the linefinder is thus "frozen" on its first step, neither linefinder relay A or D may operate (§4.5) to release group relay N. Relay N is therefore unable to release relay F which by its continuous operation (§5.5) should cause group transfer to take place and the FINDER BLOCKED lamp to light. Momentarily operate the TRANSFER RESET key to extinguish the FINDER BLOCKED lamp and return the group to normal service. Since the group's lines cannot call during the two to four minutes of the test, it is suggested that the test be made during periods of light traffic.

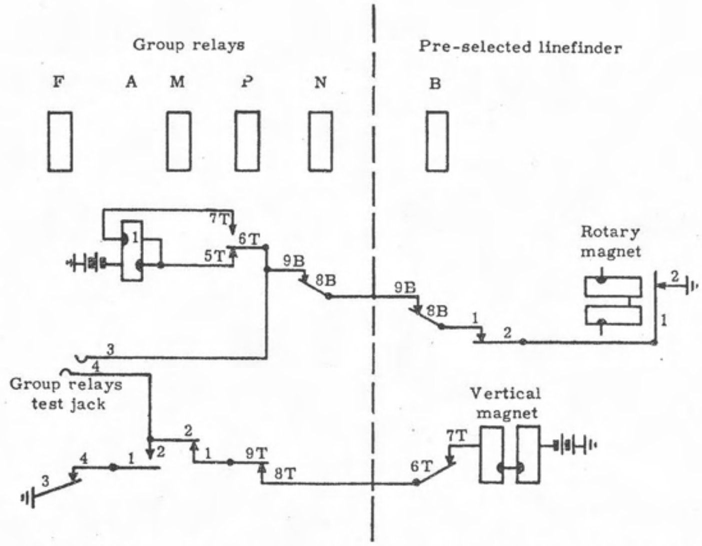


Figure 37. Circuit elements used to test "timing out" of one group relays and the transfer of its traffic to the other group.

6.56 Speed and ratio test (figure 38). Plug a suitable speed and ratio meter into group-relays test-jack spring 4 to check the preselected linefinder's stepping. Connect together the FINDER TEST or TEST LINE test jacks to operate the preselected linefinder. The same ground that operates the vertical and rotary magnets (from relay F contact 3) closes a circuit for the speed and ratio meter. Thus, the meter indicates the speed and the percent-make ratio of pulses to the vertical and rotary magnets.

Test-jack spring 3 permits similar measurements of pulses to group relay A—i.e., measurements of the speed and the percent-make ratio of the vertical-magnet and rotary-magnet interrupter contact springs.

6.6 Metering

6.61 Peg-count metering. Group relay P, operating to transfer the stepping circuit from the linefinder's vertical magnet to the rotary magnet, operates each time one of its linefinders hunts. Upon operating, relay P (figure 48) operates its associated peg-count meter to count the number of calls initiated through finders of that group. This will be a very close approximation to the number of calls originated by the subscribers of the group (but see §5.3, §6.53, and §6.54).

6.62 All-trunks-busy metering (figure 39). Group relay B releases whenever all linefinders of that group are busy (§5.2). When all linefinders of both groups are busy, both group relays B release, and operate weighted-spring relay A7. If this all-trunks-busy condition exists more than a couple of seconds, relay A7 ceases vibrating and operates relay B7 which operates the ATB (All Trunks Busy) meter, which counts the number of times all the shelf's linefinders are busy.

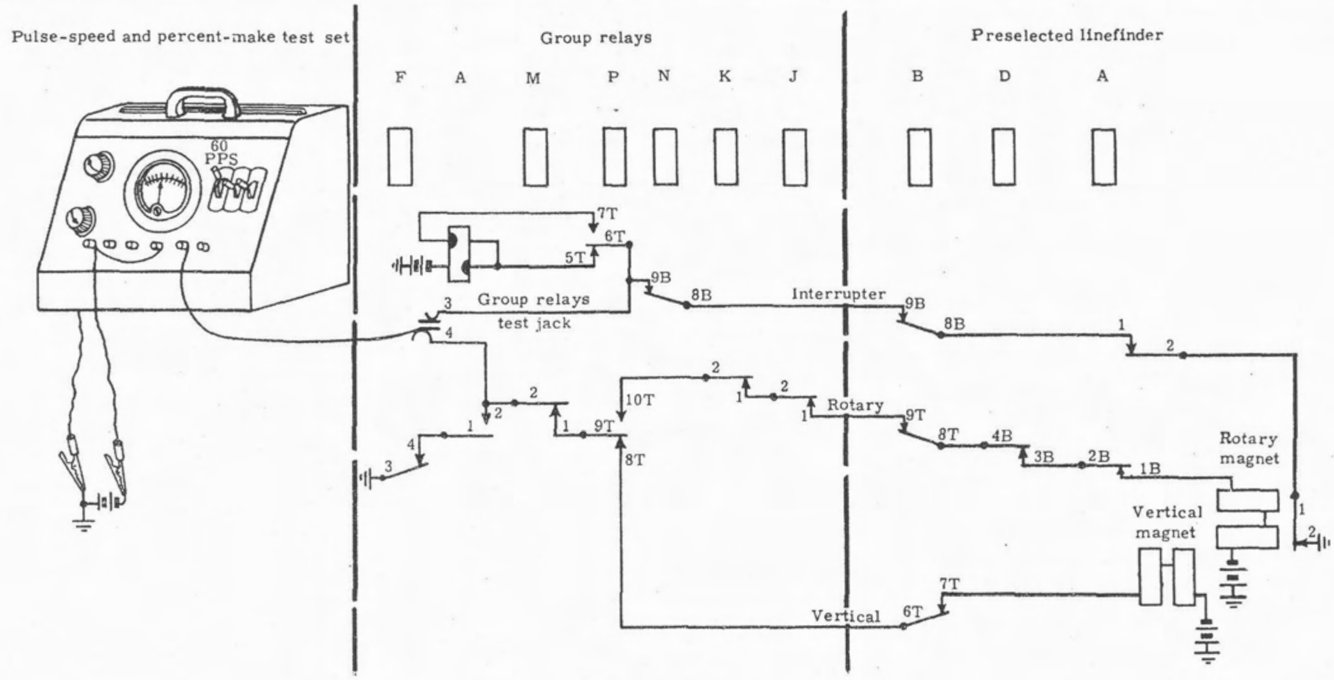


Figure 38. Stepping-speed and pulse-ratio test.

6.63 Overflow metering (figure 39). During an all-trunks-busy condition, both group relays B are released, and relays A7 and B7 are operated. Any line calling at this time will ground the level-marking and start lead and therefore operate relay C7 which will operate the OF (OverFlow) meter. This meter tends to count the number of calls attempted by calling subscribers who did not receive dial tone because all linefinders were busy, but will not give that count exactly if there are overlapping calls. A recurring high count on this meter is, however, definite indication of insufficient equipment to handle the traffic in the shelf. Usually the solution is to transfer a few lines out to a less-busy finder shelf; sometimes to exchange a few high-calling-rate lines from this shelf for lower-calling-rate lines from another shelf; or sometimes overflow shelves or additional linefinder shelves, and first selectors, will be required.

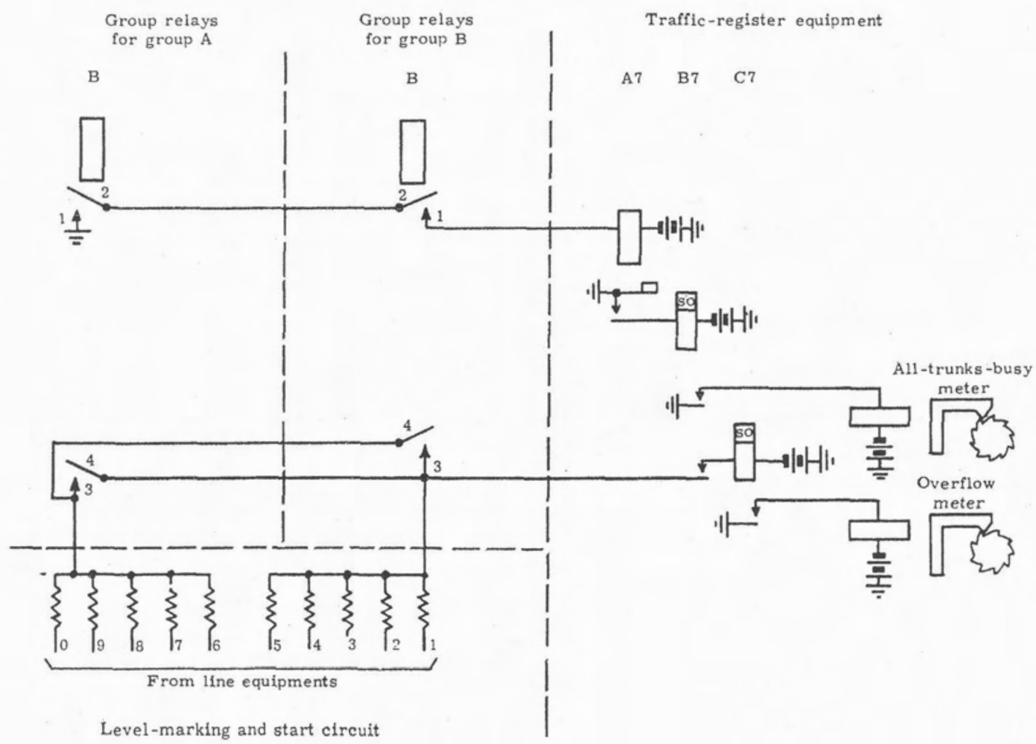


Figure 39. All-trunks-busy metering and overflow metering.

6.7 Busy keys (figure 40). Throwing a linefinder busy key grounds the linefinder GUARD lead which prevents the distributor from stopping at the busied linefinder. If the distributor is already resting on the busied linefinder's contacts, its motor magnet will operate and step it to the next idle finder. The busy key also removes ground from the finder's ATB GROUND lead so that, if all other finders of the group are being used, this busied finder will not prevent its group's relay B from releasing to permit the other group to find calling lines in this group (figure 24).

during a group transfer (§5.5), lights the FINDER BLOCKED lamp. Press the TRANSFER RESET button to release relay L and extinguish the FINDER BLOCKED lamp. The LOWER BANK lamp is explained in §6.5. The PERMANENT lamp is explained in §3.5, footnotes at bottom of page 11, §6.4, §6.41, §6.42, and §6.431.

6.9 Spark suppression. Throughout the linefinder shelf, resistor-capacitor combinations and non-inductive windings of certain double-wound relays are used as spark killers.

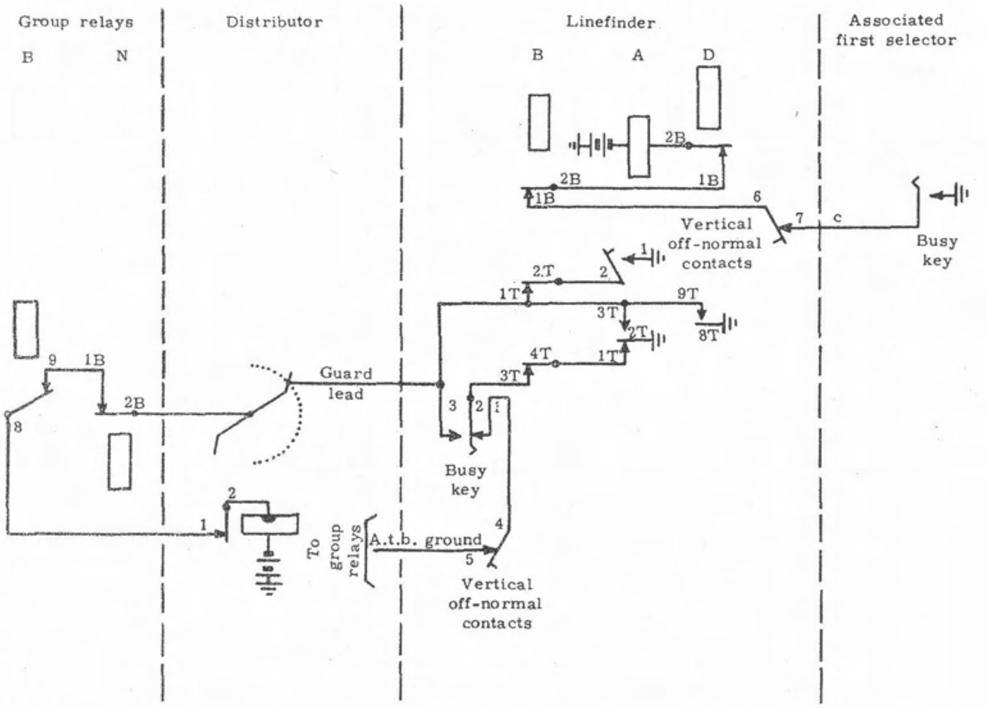


Figure 40. Busy keys of linefinder and of its associated first selector. Operation of either busy key prevents distributor assigning calls to linefinder.

Throwing the selector busy key (figure 40) operates linefinder relay A. Relay A busies the linefinder by grounding the GUARD lead and removing ground from the ATB GROUND lead.

Throwing a relay group's busy key (figure 25) releases that group's relay B which thereupon causes the other group to find all calling lines. If the FINDER BLOCKED alarm lamp was lighted, the busy key releases group relay D—but not group relay L; push the TRANSFER RESET key to cancel the alarm indication.

6.8 Supervisory alarms. Group relay C operates briefly during the hunt for a line. If a calling line is not found within $\frac{1}{4}$ to 4 minutes, relay C remains operated and the START SIGNAL lamp lights (figure 48). Group relay G operates briefly during the release of each linefinder. If a linefinder fails to release, relay G remains operated and, after a short time, lights the RELEASE lamp. Failure of any fuse on the fuse and lamp panel lights the FUSE ALARM lamp. Relay L, operating

7. TRAFFIC-GRADING OVERFLOW SHELVES

With overflow units, traffic-grading overflow service can be given 200 lines associated with from 1 to 10 regular 200-line linefinder shelves. Overflow service can be provided to the following regular 200-line linefinder shelves:

(1) Shelves arranged for 20% line-traffic grading overflow.

(2) Shelves arranged for 200-line overflow.

(3) Older shelves, not arranged for overflow.

In the case of a shelf arranged for 20% overflow, a maximum of 40 lines can be provided with overflow service. In the other two cases, a maximum of 120 lines can be given overflow service.

7.1 Description. The shelf is equipped with 2 distributor rotary switches, 6 transfer relays, alarm lamps, a fuse panel, and a 600-point bank cable. Each shelf can mount

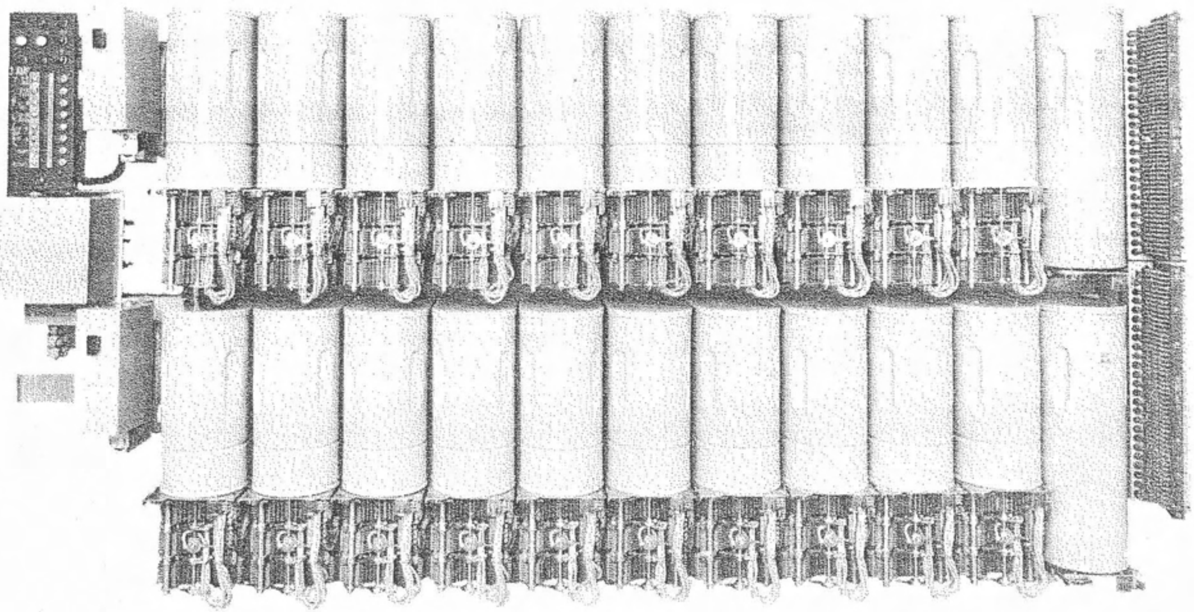


Figure 41. Typical traffic-grading overflow shelf.

20 linefinders and 2 sets of group relays. An all-trunks-busy register and a peg-count meter can mount either on the shelf or external to it. The group A linefinders and group relays are mounted above the group B linefinders and group relays. Each group contains 10 linefinders. The shelves are 5'10¾" long and approximately 2'7" high.

7.2 Application. The overflow unit 200 lines and start circuit are divided into 10 groups of 20 lines with 1 start circuit for each group. These groups are connected to specific groups of 20 lines and 1 start circuit on the regular shelves requiring overflow service. Figure 42 shows the 20-line terminal groups and associated start circuits of the overflow unit.

Overflow-shelf line-terminal groups	
Line terminals	Start-lead circuit
11-10, 111-110	1
21-20, 121-120	2
31-30, 131-130	3
41-40, 141-140	4
51-50, 151-150	5
61-60, 161-160	6
71-70, 171-170	7
81-80, 181-180	8
91-90, 191-190	9
01-00, 101-100	10

Figure 42. Overflow-shelf start-lead assignment.

Figure 43 shows the regular-shelf 20-line groups and start circuits that can be connected to an overflow shelf. Lines on regular-shelf levels 1, 5, 6, and 10 should not be connected to an overflow shelf because circuits would have to be modified.

It is recommended that regular-shelf lines 41-40, 141-140, 71-70, and 171-170 be the first to be assigned to overflow service. An equal number of lines should be brought out from group A and group B of the regular shelf, and an equal number of lines should be assigned to group A and group B of the overflow shelf so that wear on the finders of both shelves will be distributed more evenly.

Regular-shelf line groups		
Lines	Start-lead circuit	Remarks
41-40, 141-140	4	Overflow available on these lines on all shelves
71-70, 171-170	7	
21-20, 121-120	2	Overflow not available on these lines of 20% traffic-grading overflow shelf
31-30, 131-130	3	
81-80, 181-180	8	
91-90, 191-190	9	

Figure 43. Regular-shelf line and start-lead assignments.

Finder switches and line terminals are divided into groups A and B as follows:

Group A	Finders 1-10	Lines 11-50 and 111-150
Group B	Finders 11-20	Lines 61-00 and 161-100

7.3 Installation

7.31 Mounting. Overflow shelves can be ordered with mounting hardware for use on type 11, type 20, type 35E97, or other frames, and align with other shelves in a central office using the same frames.

7.32 Cabling. The type of regular shelf to which an overflow shelf is to be connected determines the method of cabling. Most cabling is done from terminal block to terminal block. However, a few of the leads must be terminated on components of older regular shelves not factory equipped for the new traffic-grading overflow.

When a regular shelf arranged for 20% line-traffic grading (figure 44) is to be cabled to an overflow shelf, connect regular-shelf terminals +, -, and C of 40 lines, and terminals STO and STI, point for point, to the same terminals on the overflow shelf. Remove the straps between regular-shelf terminals STO and STI.

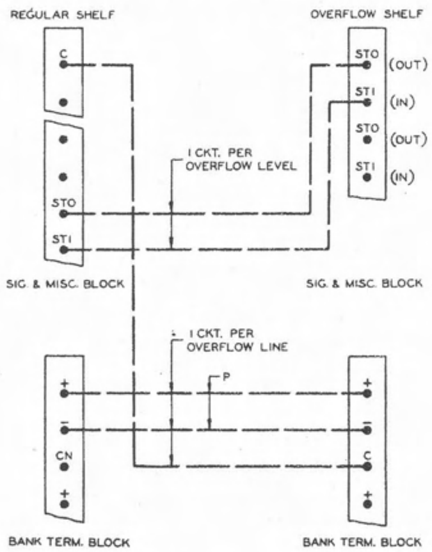


Figure 44. Cabling between overflow shelf and regular shelf arranged for 20% line-traffic-grading overflow.

When a regular shelf arranged for 200-line overflow (figure 45) is cabled to an overflow shelf, the +, -, and C terminals on each of the shelves are multipled, point for point, for each overflow line. For each overflow

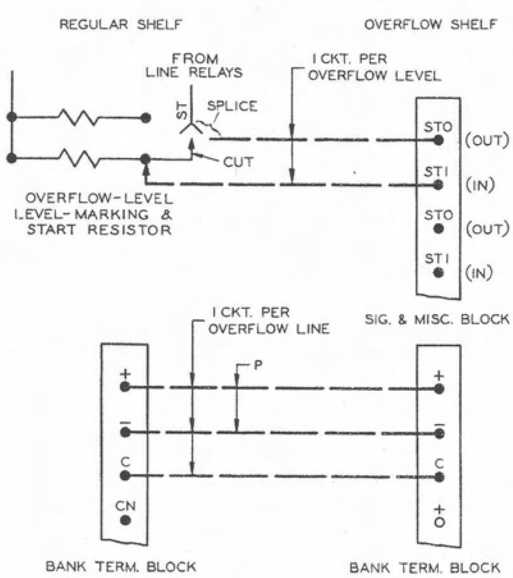


Figure 45. Cabling between overflow shelf and regular shelf arranged for 200-line overflow.

level, disconnect regular-shelf line relays' lead ST from the regular-shelf level-marking and start resistor, and cable lead ST to an overflow-shelf terminal STO. Cable the corresponding overflow-shelf terminal STI to the regular-shelf overflow-level level-marking and start resistor.

If the regular shelf is not factory-arranged for overflow (figure 46), extend each overflow line's regular-shelf lead CF from the line relay to overflow-shelf terminal C, and interconnect shelf line-terminals + and -. For each overflow level, disconnect regular-shelf line relays' lead ST from the regular-shelf level-marking and start resistor, and cable lead ST to an overflow-shelf terminal STO. Cable the corresponding overflow-shelf terminal STI to the regular-shelf overflow-level level-marking and start resistor.

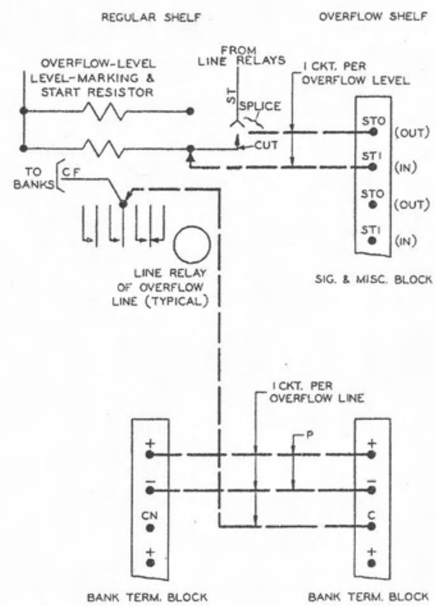


Figure 46. Cabling between overflow shelf and regular shelf not arranged for overflow.

7.4 Circuit operation. Overflow-shelf linefinder and group-relays circuits are similar to those of a regular shelf. In addition, an overflow shelf has a "transfer" circuit (figure 47). Normally overflow lines will be found by overflow-shelf finders, but when all overflow-shelf finders are busy, the transfer circuit transfers the overflow lines' start leads to the regular shelf. For example, when line relay 41 operates, the ground it places on lead STO(1) goes through relay T1 make contacts to linefinder vertical-bank contact 1 and through overflow-shelf level-marking and start resistor No. 1 to lead St.A.

When all overflow-shelf linefinders are busy, normally operated relays N release. Relay TC operates, and releases the other transfer relays, which transfer the STO leads to the STI leads and the regular shelf. As soon as a linefinder in the overflow shelf becomes idle, the AFB Chain (Out) lead is opened, relay TC releases, and the other transfer relays operate, reconnecting the STO leads to the overflow-shelf ST leads. Calls in progress during this transfer are not affected since the line and control bank contacts of the regular-shelf line-finders arranged for overflow are multipled to the line and control bank contacts of the overflow linefinders.

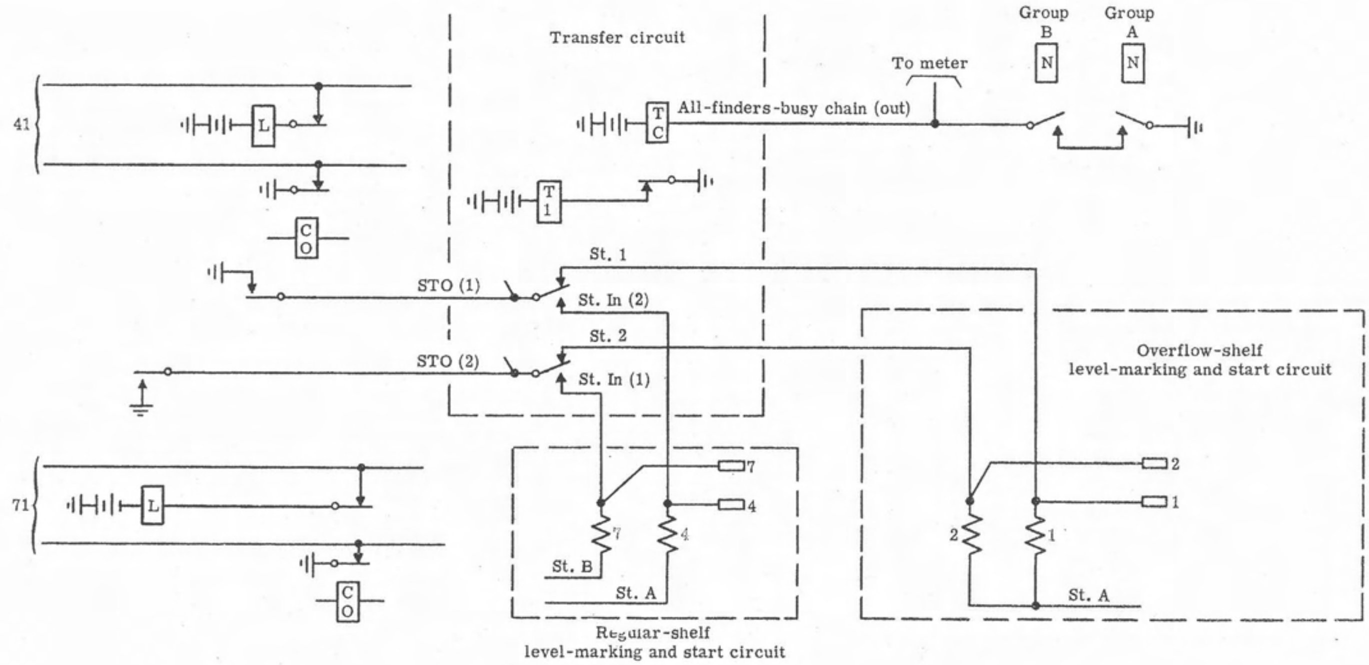


Figure 47. Overflow-shelf transfer circuit.

Revised June 1957

Printed in U.S.A. by John S. Swift Co., Inc. 2000 7-58

AUTOMATIC ELECTRIC

ORIGINATORS OF THE DIAL TELEPHONE

Makers of Telephone, Signaling, and Communication Apparatus . . . Electrical Engineers, Designers, and Consultants

Factory and General Offices: Northlake, Illinois, U.S.A.

•

ASSOCIATED RESEARCH AND MANUFACTURING COMPANIES

General Telephone Laboratories, Incorporated	Northlake, Illinois, U. S. A.
Automatic Electric (Canada) Limited	Brockville, Ontario, Canada
Automatique Electrique, S.A.	Antwerp, Belgium
Automatic Electric, S.A.T.A.P.	Milan, Italy

•

DISTRIBUTOR IN U.S. AND POSSESSIONS

AUTOMATIC ELECTRIC SALES CORPORATION
Northlake, Illinois, U.S.A.
Sales Offices in All Principal Cities

•

GENERAL EXPORT DISTRIBUTOR

AUTOMATIC ELECTRIC INTERNATIONAL
INCORPORATED
Northlake, Illinois, U.S.A.

•

REGIONAL DISTRIBUTING COMPANIES AND REPRESENTATIVES

ARGENTINA, URUGUAY, PARAGUAY, CHILE, AND BOLIVIA
D. C. Clegg
Sala 61
Rua Conselheiro Crispiniano No. 69
Sao Paulo, Brazil

AUSTRALIA
Automatic Electric Telephones Limited
86 Holdsworth Street, Woollahra
Sydney, Australia

BELGIUM AND LUXEMBOURG
Automatique Electrique, S. A.
22 Rue du Verger
Antwerp, Belgium

BRAZIL
Automatic Electric do Brasil, S. A.
Sala 61
Rua Conselheiro Crispiniano No. 69
Sao Paulo, Brazil

CANADA
Automatic Electric Sales (Canada) Limited
185 Bartley Drive
Toronto 16, Ontario, Canada

CENTRAL AMERICA
L. Pitigliani
Apartado Postal 21327
Mexico 7, D. F., Mexico

COLOMBIA
Automatic Electric de Colombia, S.A.
Apartado Aereo 3968
Bogota, Colombia

EUROPE, NORTH AFRICA, AND NEAR EAST
Automatic Electric International, Incorporated
P. O. Box 15 Geñeva Montbrillant
Geneva, Switzerland

ITALY
Automatic Electric S.A.T.A.P.
Via Bernina 12
Milan, Italy

MEXICO
Automatic Electric de Mexico, S.A.
Apartado Postal 21327
Mexico 7, D.F., Mexico

NETHERLANDS
Automatique Electrique, S.A.
Huygenstraat 6
's-Gravenhage, Netherlands

PERU AND ECUADOR
J. P. Maclaren
Apartado Aereo 3968
Bogota, Colombia

VENEZUELA
Automatic Electric De Venezuela, Compañia Anonima
Apartado 6362, Est. Caracas, Venezuela

Other Sales Representatives and Agents Throughout the World

Automatic Electric Company . . . A member of the General Telephone System