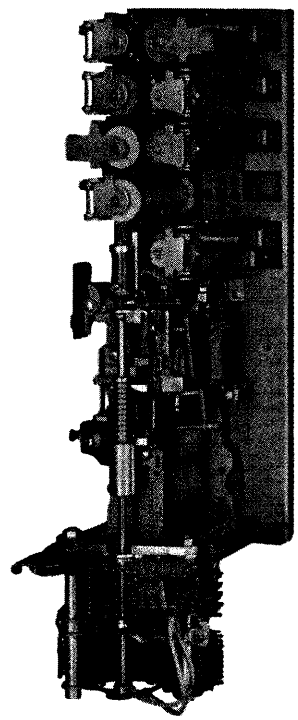
The Connector 948-807

THE CONNECTOR



Technical Bulletin 948-807

AUTOMATIC ELECTRIC
SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

THE CONNECTOR

PART I

THREE WIRE, 300-POINT BANK CONNECTOR

1. INTRODUCTION

In a step-by-step office, the equipment used to establish a connection between two parties is called a switchtrain (figure 1). Each switch of the switchtrain plays an important part in establishing the final connection between the calling and the called party. The amount of equipment or switches making up the switchtrain is determined by the size of the office (number of lines being served), destination of the call (local or interoffice) and the type of switches used.

A switchtrain must have a beginning switch and a terminating switch. The beginning switch is called a linefinder, and the terminating switch is called a connector. Any intermediate switches are called selectors. There can, of course, be other equipment added to the switchtrain; for instance, if the call is between offices, trunking equipment is required.

This bulletin presents the connector, or the terminating switch of the switchtrain. The connector presented in this bulletin responds to the last two dialed digits of the called number. When the connector has been dialed or positioned on the desired bank terminals, it tests the line for a busy or idle indication and returns busy tone to the calling party if the line is found busy. If the line is idle, the connector extends ringing current to the called line and ringback tone to the calling party. When the called party answers, the connector supplies transmission battery to both parties, and a holding ground for the entire switchtrain for the duration of the call.

The connector presented in Part I is a three wire, 300-point bank connector. Part II presents a four wire, 400-point bank connector.

2. DESCRIPTION

The operating elements of the typical connector are eight relays, a shaft with ratchet mechanism and wipers, magnets to raise and rotate the shaft, vertical-off-normal springs, a magnet to release the shaft, and a helical spring to restore the shaft, (figures 2 and 24).

In response to signals from the caller's dial, the connector raises its shaft to the level corresponding to one dialed digit, and rotates the shaft until the wipers reach the rotary position corresponding to the next dialed digit. Thus, the wipers come to rest on the bank contacts connected to the called party's line. NOTE: In a central office, a customer's line is comprised of a +lead, a -lead, and a control lead (C). These three leads are connected to the terminals of the banks mounted below the switches on the connector shelf. Two of the leads, + and -, are carried by cables outside the central office and connected to the customer's station equipment. The third lead, the C lead, does not leave the central office.

3. THE CONNECTOR SHELF

The number of connectors assigned to a group (usually comprised of 100 stations) is determined by the maximum number of calls expected to be placed to them during the busy hour of an ordinary day. Before a telephone system is installed, a study is made of the number

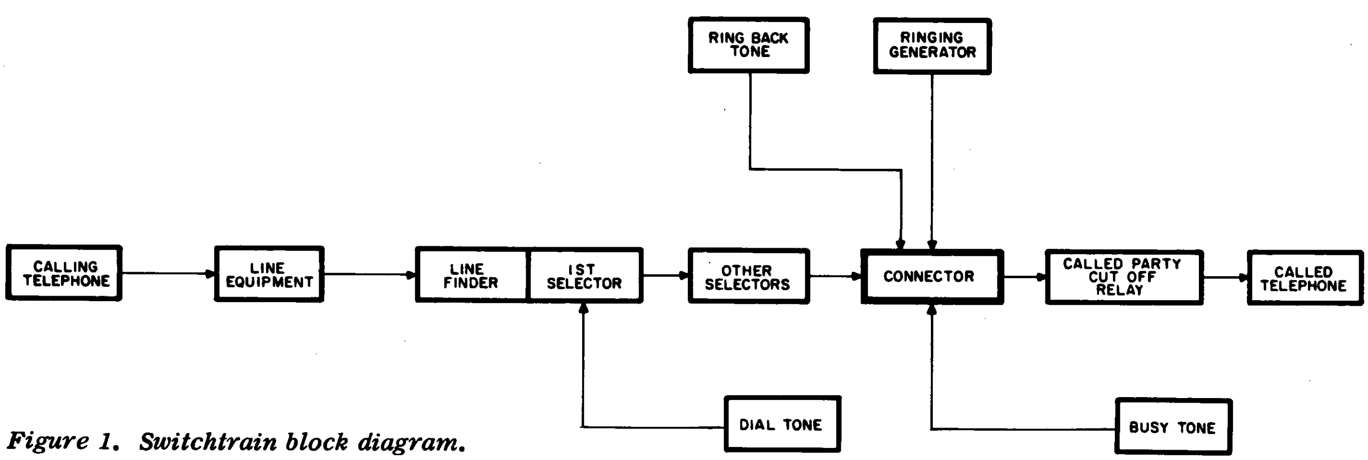


Figure 1. Switchtrain block diagram.

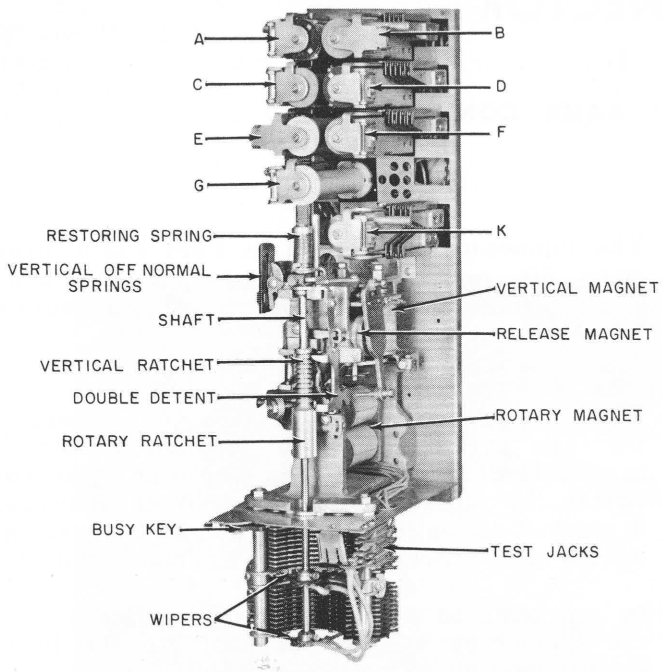


Figure 2. Eight relay local connector.

and type of customers to be served. Factories, stores, offices, and private homes must each be checked and their needs approximated. From these approximations, and past experience, equipment lists are prepared.

Connectors in an exchange are assembled in rows called shelves (see figure 3). Standard shelves of connectors are manufactured to mount either 9 or 11 connector switches with their associated contact banks (larger shelves are available for special applications). Leads which access the connector shelf from preceding switches, such as linefinders, and selectors, are either connected to a small terminal block on one end of the connector shelf, or soldered directly to the shelf jacks on the backs of the connector switches.

Each connector may provide connection to 100 telephones; therefore, each shelf will access 100 telephones. Figure 3 shows a shelf of seven connectors with room for expansion to nine. The connector on the left, with only three relays, is a test connector. The wires representing 100 telephones appear in the banks below each connector. The banks of each connector are multipled, and the 300 wires from the banks are terminated on the terminal block at the right side of the shelf. At this terminal block the wires are joined to cables which will connect them to line equipment and the customer's telephone.

3.1 The Connector Banks

The 100 lines served by a connector shelf are multipled to the banks of contacts mounted below each switch on the shelf. Figure 4 shows two banks of contacts and the associated wipers which comprise a 300-point bank. Both banks of contacts have ten levels; however, the upper bank uses 100 bridging contacts, while the lower bank uses a 200-point bank having two contacting surfaces in each position.

Bridging contacts have a wide flat surface which allows the wiper to make a connection to the next contact before breaking the connection with the contact it is moving from. Bridging contacts are used on the upper bank to reduce friction as the wiper passes from one contact to another on a level. There are ten contacts across each level of this bank, and the C lead corresponding to a particular line is connected to each contact. (C leads are used in the central office exclusively, and never leave the exchange building.)

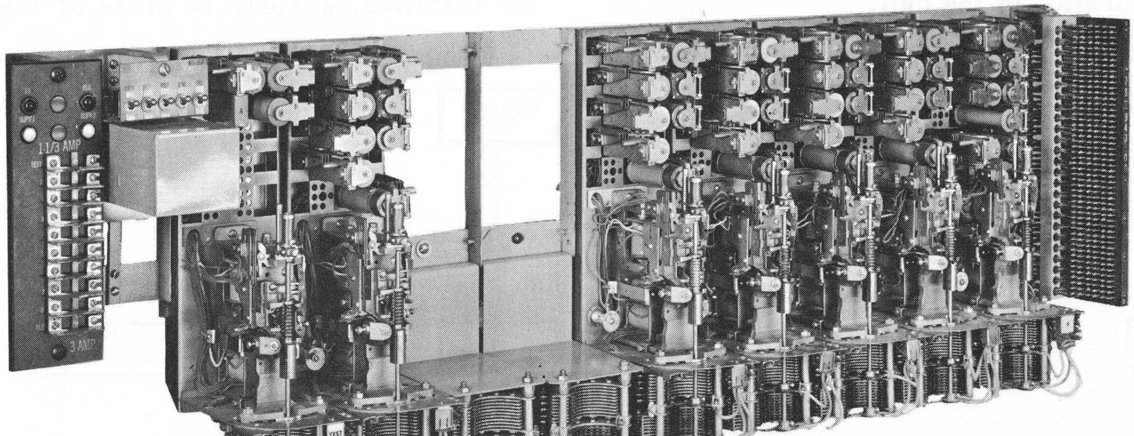


Figure 3. Connector shelf.

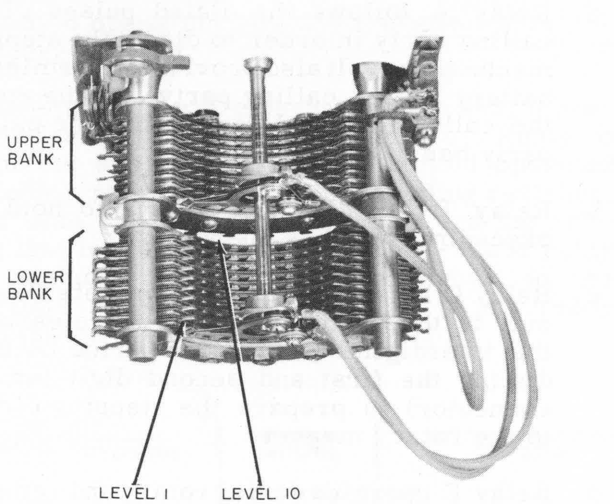


Figure 4. A 300-point bank with quick change wipers.

The lower bank is a 200-point bank on which the + and - leads of each line terminate. Each of the ten levels on this bank has ten positions similar to those of the upper bank; however, each position has two contact surfaces rather than one. A 200-point bank is made by separating two contacts with a piece of insulating material. The contacts on this bank are always non-bridging.

The method of numbering the bank contacts is illustrated in figure 5. The bank levels are numbered from bottom to top, while contacts on these levels are numbered from left to right. The numbers shown for each terminal are actually the last two digits of the customer's directory number.

4. MECHANICAL OPERATION

A connector is capable of connecting its wipers to any one of the one hundred bank contacts of the two banks. Since these bank contacts are arranged in ten levels, each level containing ten contacts, the connector must be capable of stepping its shaft and wipers vertically to reach ten levels and rotary to reach any one of the ten contacts on that level. Two dialed digits are required by the connector to perform these functions.

4.1 Vertical Stepping

Raising or stepping the shaft vertically is done by relaying current pulses to the vertical magnet. With each pulse, the vertical magnet is energized and the pawl associated with the vertical armature presses upward against the vertical ratchet teeth, causing the shaft to be raised one vertical step or level. For example, if the digit 4 is dialed, four pulses are relayed to the vertical magnet, and the shaft is stepped vertically to the fourth level. There is a groove on the left side of the vertical teeth which allows the shaft to pass the stationary detent during vertical movement or release. The stationary detent is used to hold the shaft at the selected vertical level during rotary stepping.

4.2 Rotary Stepping

During the pause between the first and second digit dialed into the connector, the circuit to the vertical magnet is opened and the circuit to the rotary magnet is prepared. The next dial pulses (second digit) cause the shaft to rotate through the action of the rotary ratchet's pawl connected to the armature of the rotary magnet. The movement of the armature of the rotary magnet causes the wipers to travel across the bank contacts to the contact corresponding to the number of pulses received by the rotary magnet.

4.3 Release

A spring loaded double detent (dog) holds the vertical and rotary ratchets in the desired position. When both parties conclude the call, the release magnet is energized and the double detent is withdrawn from the teeth of the vertical and rotary ratchets. At this point, the restoring spring's tension forces the wipers to restore to rotary normal. When the shaft and wipers are clear of the bank, the weight of the shaft causes it to drop to vertical normal position. The circuit to the release magnet is opened by the vertical off-normal springs.

5. LINE EQUIPMENT

Before discussing the circuit operation of the connector, a word should be said about line

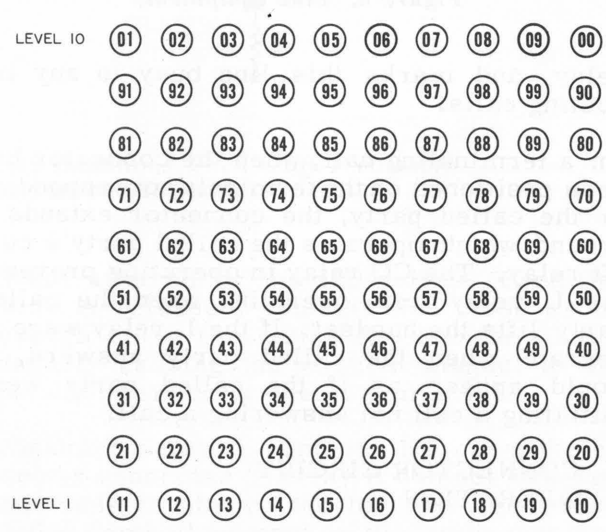


Figure 5. Bank contact position numbering.

equipment. As shown in figure 1, line equipment is inserted between the calling party and the switchtrain, and the switchtrain and the called party. The line equipment circuit is shown in figure 6 and consists of a line relay (L) and a cut-off relay (CO). In order for a party to initiate a call, the switchtrain is accessed through the operation of the L relay. The L relay operates when the calling party lifts the handset off-hook. The L relay in operating grounds the START lead to signal the linefinder of a call for service, and also marks the calling party's terminal on the linefinder bank. Once a linefinder has found the calling party, and the calling party is connected to the switchtrain, there is no need to start other linefinders looking for this line, so the CO relay corresponding to the line is energized. Energizing the CO relay releases the L

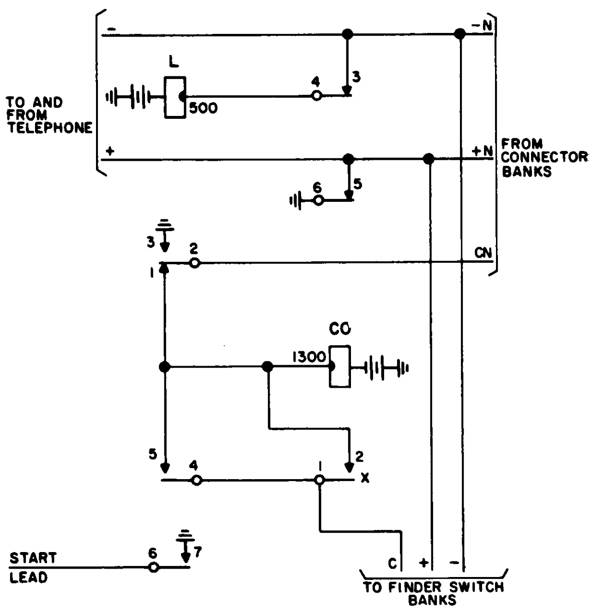


Figure 6. Line equipment.

relay, and marks this line busy to any incoming calls.

On a terminating call, when the connector has been positioned on the terminals corresponding to the called party, the connector extends a ground which operates the called party's cut-off relay. The CO relay in operating prevents the L relay from operating when the called party lifts the handset. If the L relay were to operate when the called party answers, it would appear as if the called party were initiating a call not answering a call.

6. CONNECTOR CIRCUIT OPERATION

The following, in brief, are the functions performed by the eight connector relays:

a. Relay A follows the dialed pulses of the calling party in order to direct the stepping mechanisms. It also provides transmission battery to the calling party. At the end of the call, relay A detects when the calling party has disconnected.

b. Relay B supplies the ground to hold the preceding switches operated.

c. Relay C holds operated to complete the circuit to the vertical magnet. It releases in the interdigital pause (the period between dialing the first and second digit into the connector) to prepare the stepping circuit to the rotary magnet.

d. Relay E operates during rotary and remains operated long enough after rotary stepping to allow the connector to perform the busy test.

e. Relay G operates if the called line is busy, and returns busy tone to the calling party.

f. Relay K in operating connects the + and - leads to the wipers and the called line.

g. Relay F operates when the called party lifts the handset off-hook to remove ringing current from the line.

h. When the called party lifts the handset off-hook, relay D also operates and provides transmission battery to the called party and reverses the battery potential towards the calling end to supply answer supervision.

6.1 Seizure

When the calling party lifts the handset, a circuit is closed to the central office, operating the line relay (L) of the line equipment. Relay L (figure 6) grounds the start lead which causes the linefinder to hunt for and connect to the calling party. The linefinder has a first selector tied to its wipers. The first selector is seized and provides dial tone. Relay CO operates, and releases relay L.

The calling party proceeds to dial through the first and intermediate selectors. When the wipers of a battery-searching selector contact the terminals corresponding to an idle connector (figure 7), battery through connector relay C operates relay C and energizes selector relay F winding No. 1, thereby closing the X contacts of relay F. The X contacts close a circuit through relay F battery connected winding No. 2, which operates relay F completely. Relay F extends the loop from the calling telephone through the line wires to connector relay A, connects the C lead of the preceding switch with lead C of the connector, and also opens the circuit of selector slow-to-release relay B.

Connector relay A closes contacts 2-3, thereby operating connector relay B. Relay B contacts 8-9 ground lead C to hold operated selector relay F and other preceding switches, and also to mark this connector and the calling line busy. Relay B contacts 4-5, and relay C contacts 2-3 prepare the circuit to the vertical magnet. The connector is now ready to receive dial pulses.

ground from the selector immediately after relay F operated.

6.2 Vertical Stepping (Figure 8)

As the calling party dials the tens digit (next-to-last digit) of the called number, his dial alternately opens and closes the circuit of relay A. The number of times the circuit is opened corresponds to the digit dialed. Relay A releases during each interruption; however, slow-to-release relay B remains operated and

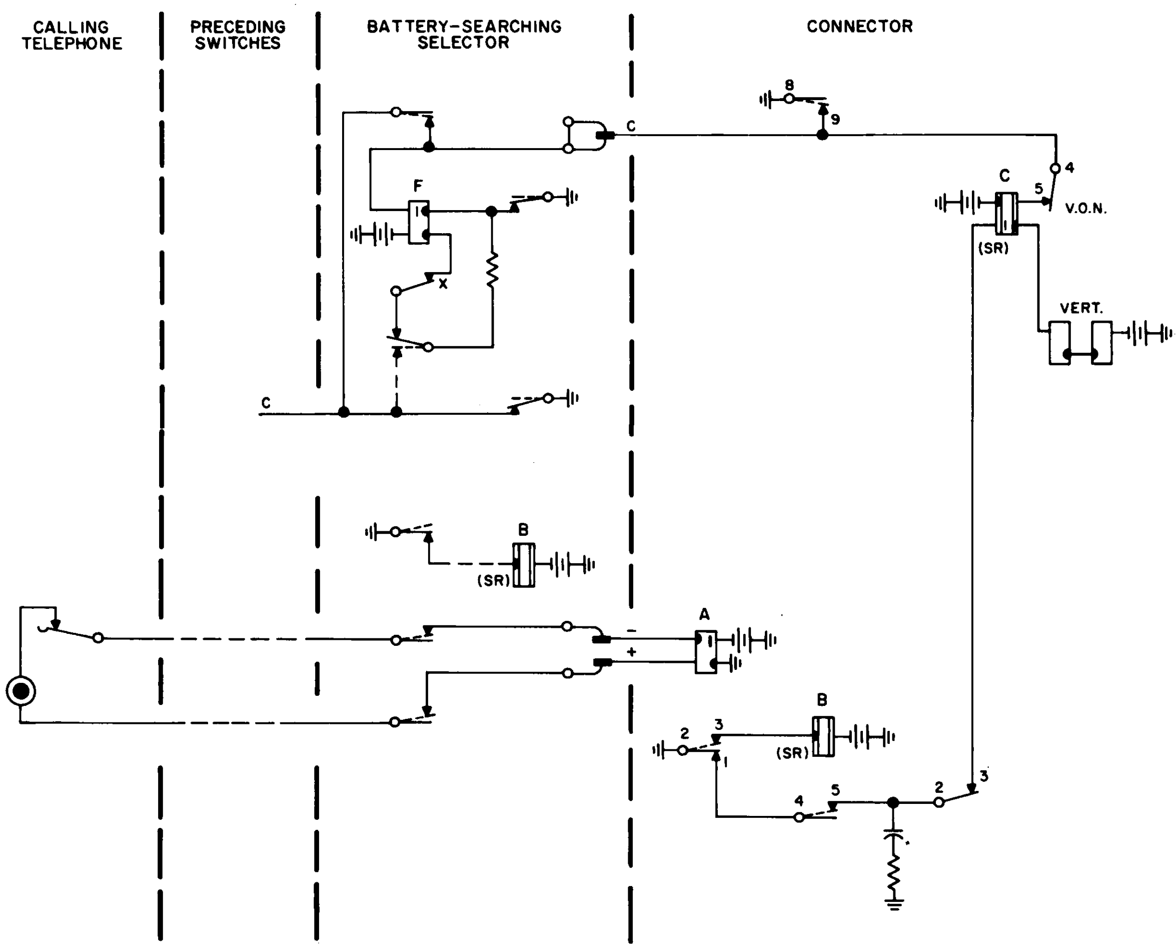


Figure 7. Seizure. Solid armatures show initial conditions when relay F contacts "X" close. Dotted armatures show final conditions.

If an absence-of-ground searching selector is used with this connector, (instead of a battery searching selector), selector relay F will have only one winding, and will operate unless lead C is grounded and short-circuits relay F. Relay F operates as above, closes a circuit through connector relay A, and connects preceding-switch lead C to lead C of the connector. In this case, battery for operation of relay F comes from within the selector, and connector relay C does not operate in series with selector relay F, but is operated by

is not affected by the dial pulses. Each time relay A releases, contacts 1-2 close ground through relay C winding No. 1 to the vertical magnet, causing the vertical magnet to step the shaft vertically one step or level.

Whenever relay A contacts 1-2 open, the capacitor connected to relay B contact 5 charges and tends to absorb the high voltage induced in the vertical magnet as the vertical magnet circuit is opened. This suppresses sparking at relay A contacts 1-2. Each time relay A

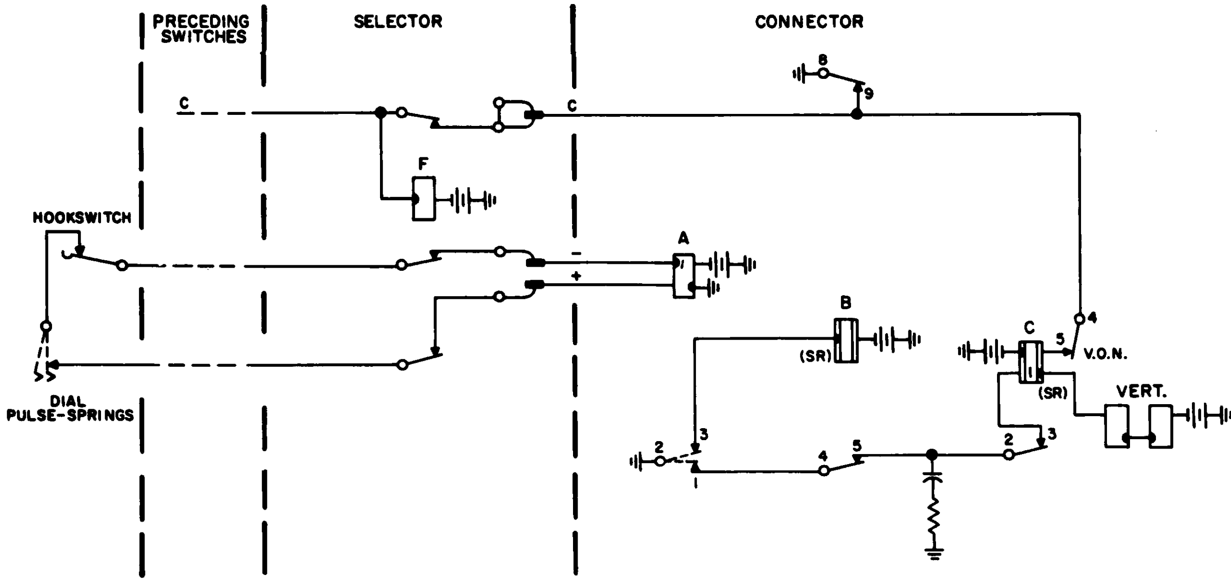


Figure 8. Vertical stepping.

contacts 1-2 reclose, the resistor at relay B contact 5 limits capacitor discharge current to prevent spot-welding the A contacts together.

During the first vertical step, V.O.N. (vertical off normal) springs 4-5 open the circuit to relay C winding No. 2. Relay C winding No. 1 in series with the vertical magnet energizes during the first pulse, and holds slow-to-release relay C operated until the pulses of the tens digit end. During the interdigital pause (the period of time between the first and second digit dialed into the connector), the C relay restores and prepares the circuit to the rotary magnet.

The dial pulse springs are closed during the interdigital pause keeping relay A operated. Relay A holds relay B operated, which in turn at contacts 8-9 keeps ground on lead C to hold the preceding switches operated, and to mark this connector and the calling line busy to other calls.

6.3 Rotary Stepping (Figure 9)

As the units digit (last digit) is dialed, relay A pulsing contacts again open and close corresponding to the number of pulses in the dialed digit. Ground pulses from relay A contacts 1-2 are closed through operated contacts 4-5 of relay B, contacts 2-1 of relay C restored, contacts 1-2 of unoperated relay G, to relay E, and through contacts 3T-4T of relay K to the rotary magnet. The rotary magnet rotates the shaft one rotary step for each pulse received. Relay E, in operating at contacts 5-6, prevents interruption of the pulsing path to rotary magnet circuit if wiper C sweeps over a busy (grounded) contact which momentarily operates relay G. As soon as slow-to-release relay E operates, its contacts 2-4 connect

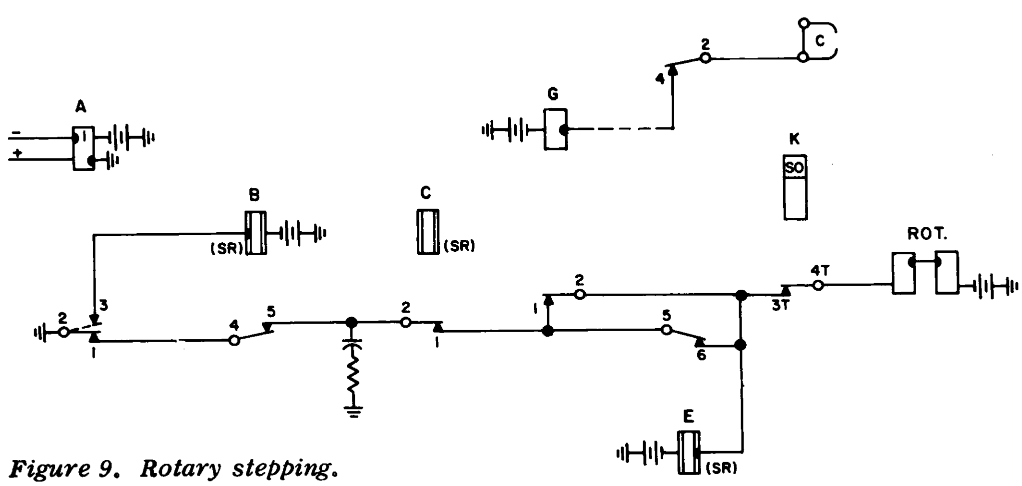


Figure 9. Rotary stepping.

wiper C to the winding of relay G, preparing the circuit for the busy test. As soon as pulsing stops, a busy test is made on the called line.

6.4 Testing the Called Line

6.4.1 Called line busy (figure 10).

Upon completion of pulsing, the wipers are positioned on the bank contacts of the called line. If this line is busy, the C bank contact is grounded. This ground then is connected through the C wiper to relay G. Relay G operates and at contacts 4-5 prepares its own holding circuit when relay E releases, and contacts 6-7 return busy tone to the calling party.

After its slow-to-release interval, relay E releases, contacts 5-6 break, preventing further rotary stepping if the calling party should operate the dial, and contacts 3-4 make, before contacts 2-4 break, locking relay G operated. Relay G contacts 3-4 are opened to prevent relay K from operating if the called line were to become idle before the calling party hangs up, even though the wipers continue to rest on the bank contacts of the called line.

6.4.2 Release from a busy line (figure 11).

When the calling party hangs up, relay A releases, opening the circuit to slow-to-release relay B. When relay B releases, its contacts 8-9 remove the holding ground from relay G. Relay G releases.

As relay B releases, its contacts 1-2 complete the circuit to the release magnet. Mechanical release then takes place as described in paragraph 6.8.3.

6.4.3 Called line idle (figure 12).

If the called line is idle the C wiper encounters battery through the called party's cut-off relay. Relay G does not operate. After its slow-to-release interval relay E releases and completes a circuit from battery through the winding of relay CO, wiper C, relay E contacts 2-1, relay K winding No. 1, relay G contacts 3-4, V.O.N. contacts 3-4, and relay B contacts 8-9 to ground, energizing relay K.

6.5 Seizure of the Called Line (Figure 13)

The current through winding No. 1 energizes slow-to-operate relay K enough to close only its X contacts 1T-2T. Relay K is then fully energized by battery through the rotary magnet, relay K winding No. 2, relay K contacts 1T-2T, relay B contacts 6-7, relay E contacts 1-2, relay K winding No. 1, relay G contacts 3-4, V.O.N. contacts 3-4, and relay B contacts 8-9 to ground. This ground is also used to operate the CO relay in the called party's line equipment. Operating the CO relay marks the line busy to other calls, and prevents the L relay of the called line from interfering with ringing as when the call is answered.

The high resistance of relay K winding No. 2 allows only a small current flow not sufficient to operate the rotary magnet. Relay K contacts 5T-6T short-circuit winding No. 1 and close a holding ground to the CO relay. In a small central office where the ringing machine does not operate continuously, ground at contacts 7T-8T of relay K is used to start the ringing machine.

6.6 Ringing

One of the main functions of the connector is to extend ringing current from the ringing machine to the called line. As can be seen in figure 14 central-office battery (d-c) is also on the lead with the ringing current (a-c). Although the ringing current flows through the winding of relay F, its slug and sleeve make relay F too slow-to-operate on a-c. The capacitor in series with the ringer blocks the d-c until the called party lifts the handset. When the called party lifts his handset a d-c path is completed to relay F, allowing relay F to operate.

The complete ringing cycle is six seconds. Under the control of an external timing cam the ringing frequency is placed on the line for a period of 1.2 seconds and removed from the line for a period of 4.8 seconds. During the silent interval (4.8 seconds) when the called telephone is not being rung, central-office battery (figure 14) is supplied to the line which will allow relay F to operate.

6.6.1 Ringing the called line.

Operated relay K at contacts 5B-6B and 7B-8B completes the path for supplying ringing current to the called line. A capacitor in the called party's telephone blocks d-c and prevents relay F from operating until the handset is lifted. In figure 14 ringing current is closed through winding No. 1 of relay F, through contacts 3-4 of relay F, 7B-8B of relay K, through the capacitor and ringer of the called telephone, 5B-6B of relay K, and contacts 7-8 of relay F to ground. Relay K also at contacts 9T-10T closes ringback tone to the calling party.

6.6.2 Release from an unanswered call.

If the called party does not answer, relays D and F do not operate. When the calling party hangs up, the circuit to relay A is opened. Relay A releases, and removes the ground

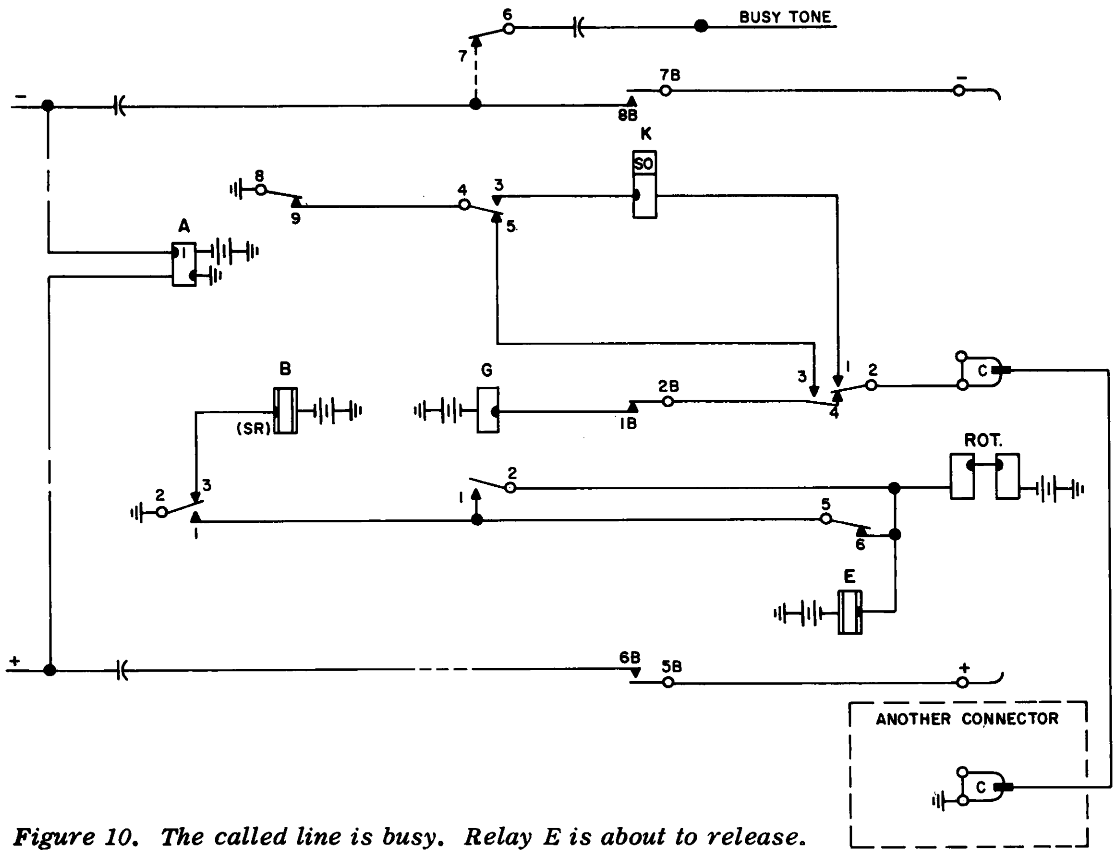


Figure 10. The called line is busy. Relay E is about to release.

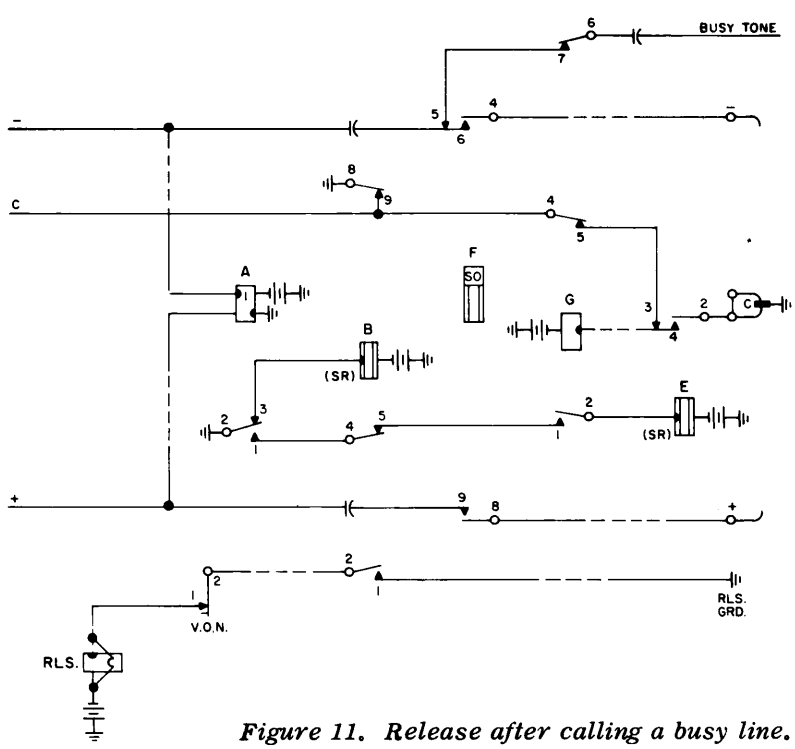


Figure 11. Release after calling a busy line.

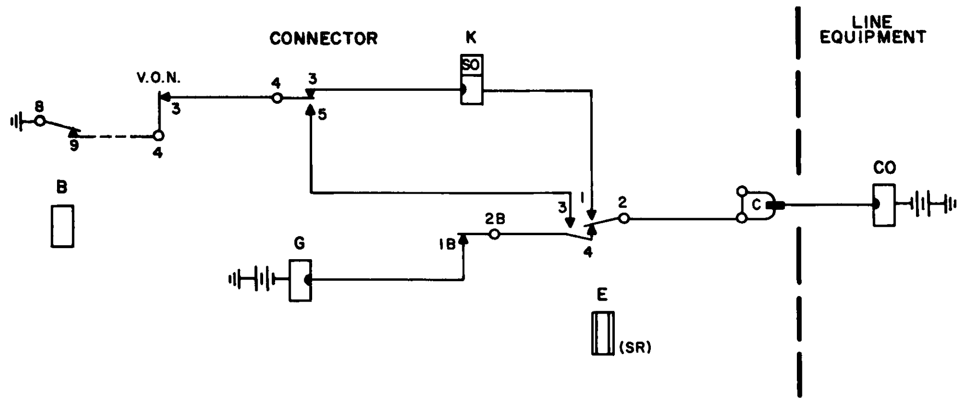


Figure 12. The called line is idle. Relay E is about to release.

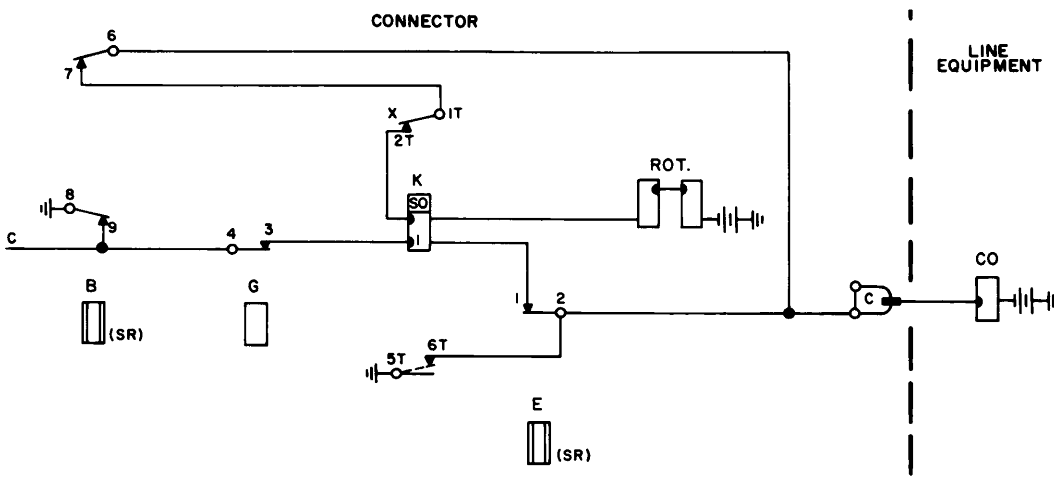


Figure 13. Seizure of the called line. Relay K winding number one closes "X" contacts.

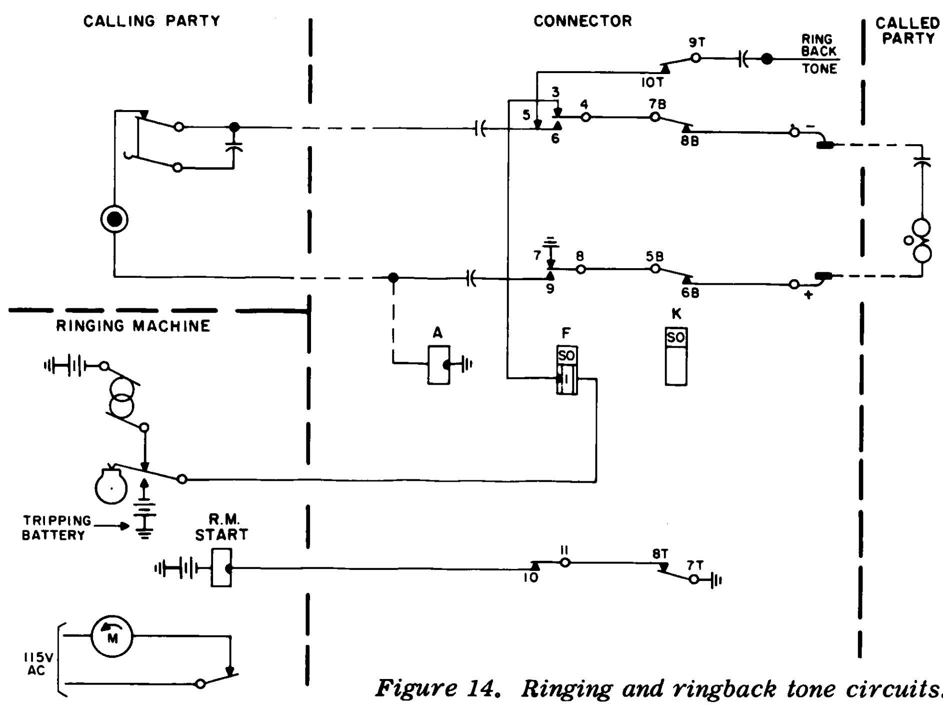


Figure 14. Ringing and ringback tone circuits.

from slow-to-release relay B. After its slow-to-release interval, relay B releases. Its contacts 8-9 remove the holding ground from relay K. Relay K releases, cuts off ringing and ringback tone, and completes the circuit to the release magnet. Mechanical release will take place as described in paragraph 6.8.3.

6.6.3 Ringing cutoff (figure 15).

When the called party answers, by lifting the handset, a d-c path is completed through the transmitter and induction coil to relay F winding No. 1. Relay F closes its "X" contacts. 6-7-8 and 9-10-11 reverse the polarity of the battery originally supplied to the calling party by relay A. Battery reversal is known as "Answer Supervision", and has a useful function as in the following cases:

(1) If the call is from a paystation, it results in collection of the coins deposited for the call.

(2) In a measured-service or message-rate exchange, it counts completed calls.

(3) Gives off-hook (answer) supervision to an operator on a call she has placed.

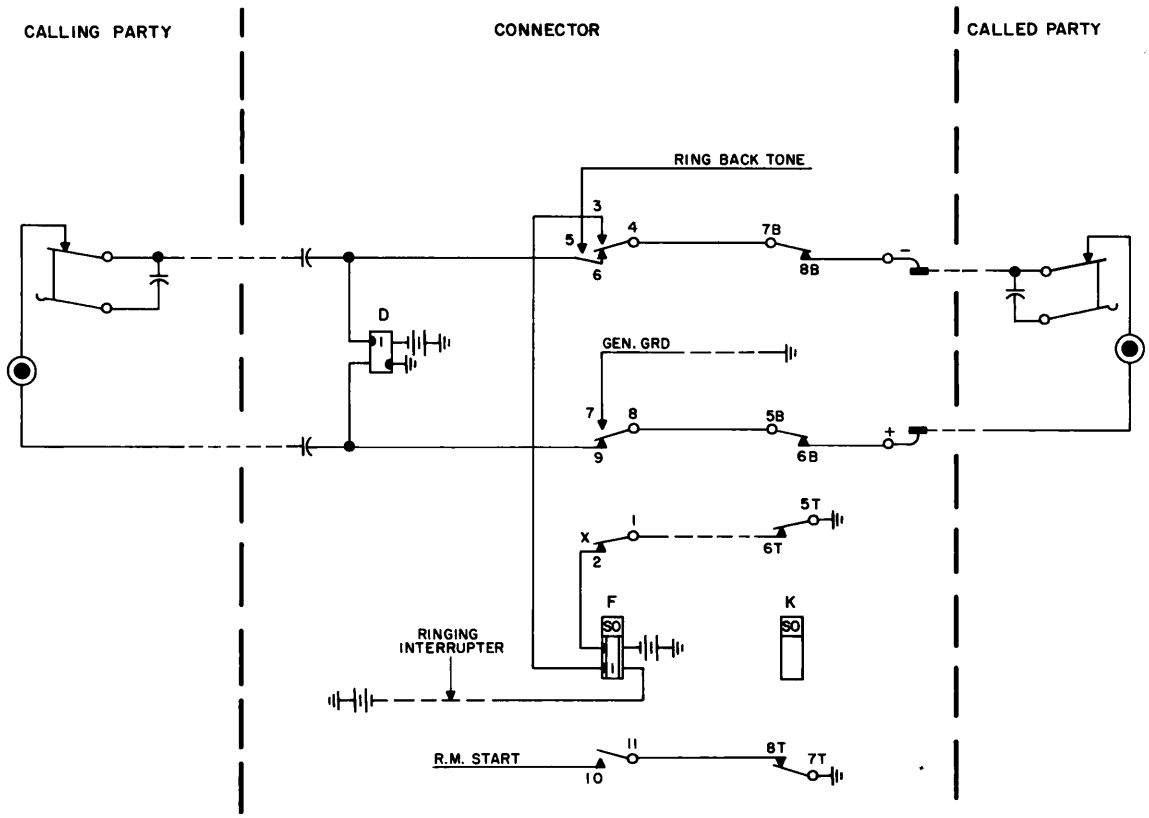


Figure 15. Called party answers. Relay F has operated, and ringing is cut off.

Closing the X contacts energizes winding No. 2 of relay F, and relay F operates completely. Relay F contacts 3-4-5-6 cut off ringing current to the line and ringback tone to the calling party, and complete one side of the transmission path. Relay F contacts 7-8-9 disconnect generator ground and complete the other side of the transmission path. When desirable to do so, relay F contacts 10-11 stop the ringing machine.

6.7 Conversation (Figure 16)

Relay D supplies transmission battery to the called party. The make before break contacts

(4) On a call placed through the Direct Distance Dialing network, battery reversal starts a timer to time the length of the call.

Simplified conditions for conversation are shown in figure 17, which is a typical example of a 1,000 line switchtrain consisting of a linefinder, selector, and connector. Voice transmission between called party and calling party is through capacitors N and P.

On local calls, the coils of relays A and D in the connector are the only relay coils connected across the transmission path. Relay A

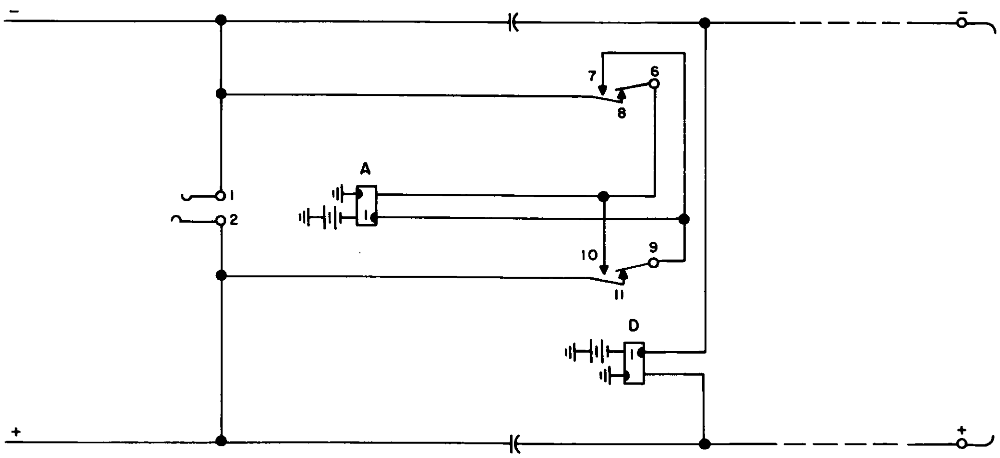


Figure 16. Reverse battery to caller for answer supervision.

supplies transmission battery to the calling party, and relay D to the called party. Relay A holds relay B energized, which maintains a ground on lead C holding operated the calling party's cut-off (CO) relay, the linefinder, the selector, and also initially marks the calling party's line busy on the banks of all the connectors on which it appears. Relay K keeps ground on wiper C to hold the called party's cut-off relay (CO), and marks the called line busy.

Figure 18 shows the connector's internal holding scheme for last party release (with "W" strap). Relay A contacts 2-3 hold relay B. Ground through relay B contacts 6-7 and 8-9 allows the calling party to hold relays F and K operated, thereby keeping the transmission path closed. The called party also holds relays F and K operated through relay K contacts 7T-8T and relay D contacts 2-3. The two conversing parties now have joint control of the connector, and either or both can hold it. In this way the connector's wipers will be held on the contacts of the called line until the last party has hung up.

In some instances it is desirable to have the calling party release the connector. For calling party release, the "W" strap is omitted. When the calling party hangs up, relay A releases, and opens the circuit of slow-to-release

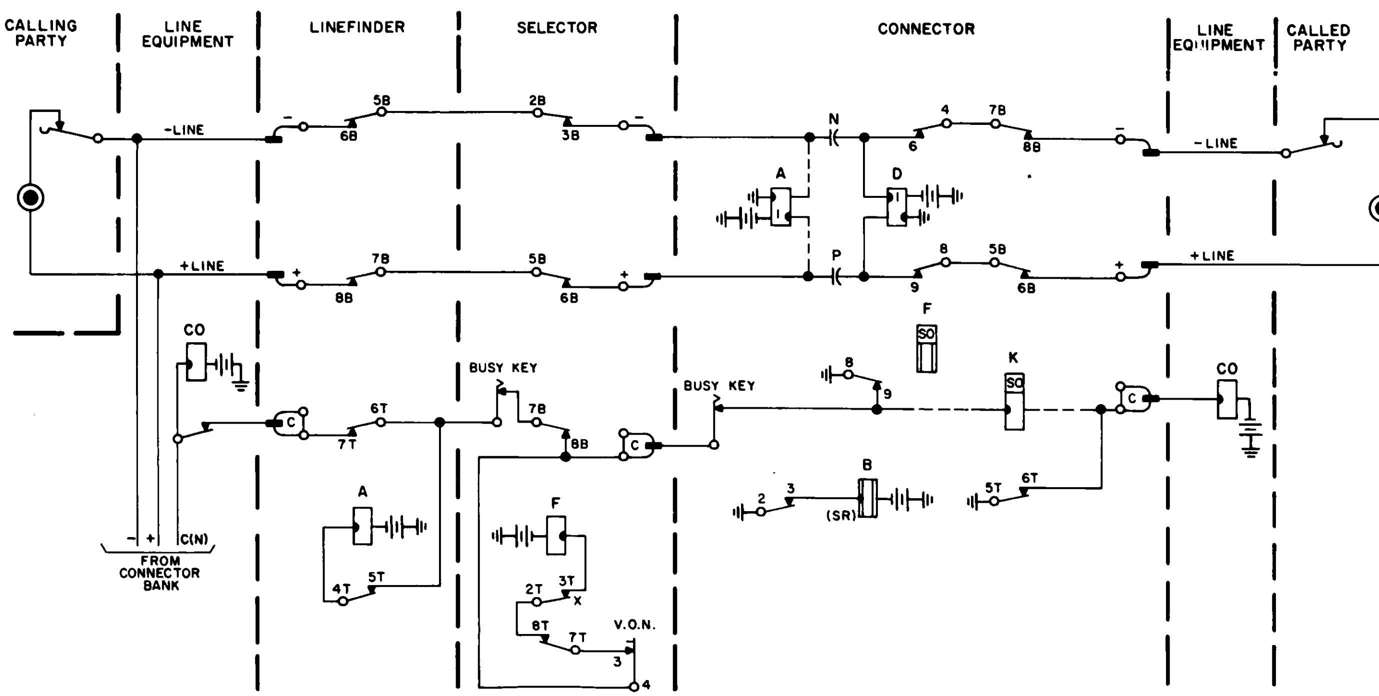


Figure 17. Conversation through local switchtrain in a 1000 line central office.

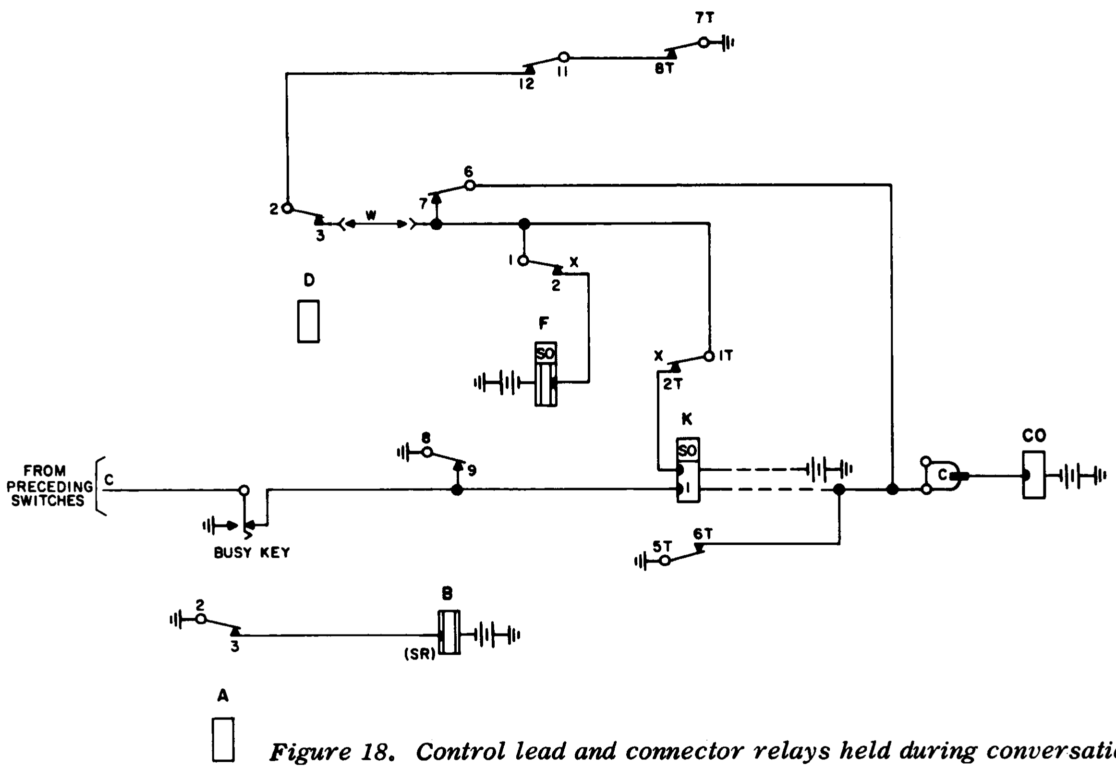


Figure 18. Control lead and connector relays held during conversation.

relay B. After its slow-to-release interval, relay B releases. Contacts 6-7 open the holding ground of relays F and K. These relays release after a short interval and open the talking path. Opening the talking path opens the holding path of relay D. Relay D releases.

Relay K (released) completes the path to the release magnet, and mechanical release takes place as described in paragraph 6.8.3.

6.8 Release

6.8.1 Calling party hangs up first.

The calling party's hookswitch opens the circuit to relay A (figure 19). Relay A releases, opening the circuit of slow-to-release relay B, and also operates relay E. Relay B releases, at contacts 8-9 removes ground from lead C which allows the preceding switches to release, and at contacts 4-5 opens the circuit of slow-to-release relay E. Relay E (released) connects ground from relay K contacts 5T-6T, through relay E contacts 1-2, relay K winding No. 1, relay G contacts 3-4, V.O.N. springs 3-4, to lead C, keeping the connector marked busy.

When the called party hangs up, the circuit to relay D is opened. Relay D at contacts 2-3 opens the circuit to relays F and K. Relay K opens the circuit to the wipers, and contacts 3B-4B close the circuit to the release magnet. (See paragraph 6.8.3.)

6.8.2 Called party hangs up first.

Relay D releases, opening contacts 2-3; however, contacts 6-7 of relay B continue to hold relays F and K operated. Nothing further can happen until the calling party hangs up, releasing relay A. As soon as relay A releases, relay E reoperates, but serves no purpose. Relay B releases, removing the ground from lead C, to release the switchtrain, and at contacts 6-7 opens the circuits of relays E, K, and F. Relay K opens the path to the wipers, and closes the circuit to the release magnet. (See paragraph 6.8.3.)

6.8.3 Mechanical release (figure 20).

The release magnet is energized by ground through relay K contacts 3B-4B, relay B contacts 1-2, relay D contacts 1-2, and V.O.N. springs 1-2. Energizing the release magnet withdraws the double detent, and latches it under the release link (figure 21). Tension of the helical spring on top of the shaft rotates the shaft and wipers to the left and off the banks, where the weight of the shaft restores it to normal.

As soon as the shaft drops to its normal position the vertical off normal springs operate. The V.O.N. springs 1-2 open the release magnet circuit, and V.O.N. springs 4-5 (figure 24) place 500-ohm resistance battery on the C lead to mark the connector idle.

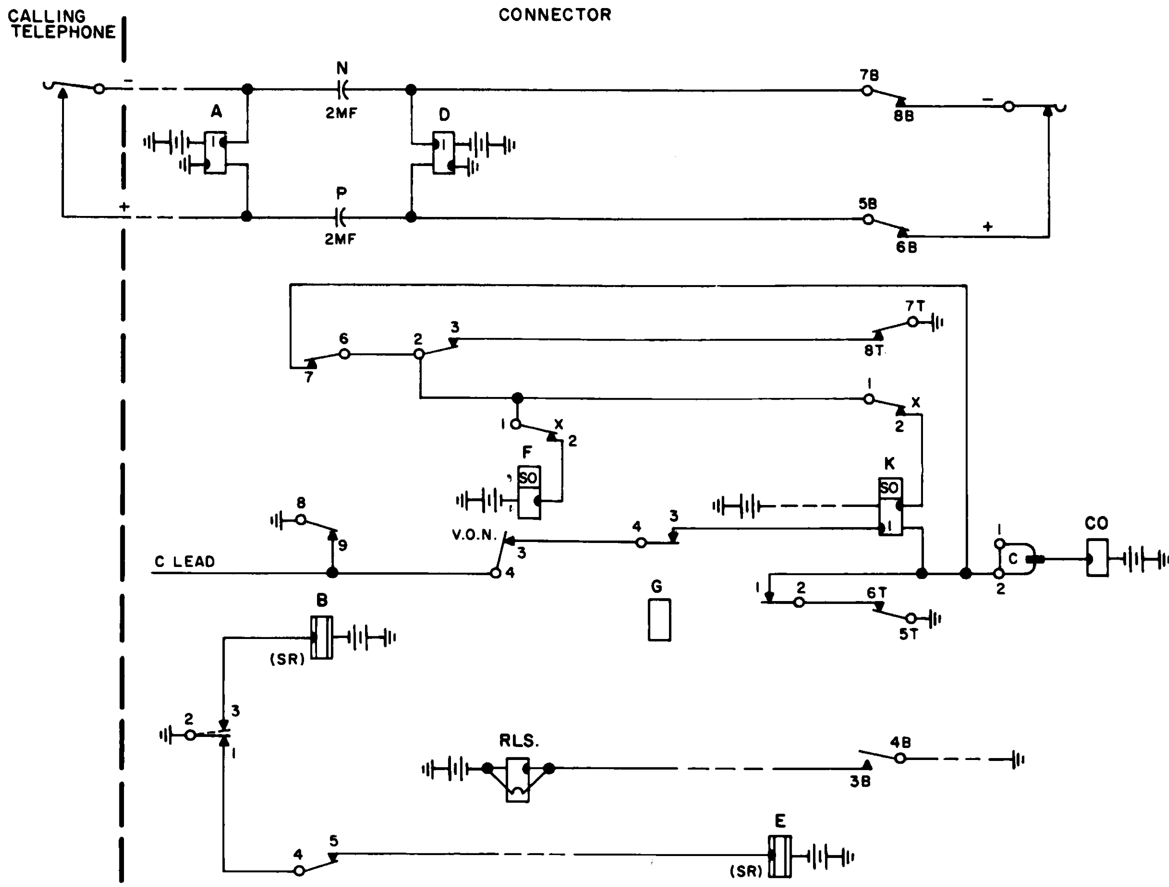


Figure 19. Switchtrain release.

7. SUPERVISION

Figure 3 shows a fuse panel mounted on the left side of the connector shelf. On the fuse panel are two supervisory lamps (SUPY-1, SUPY-2) a release alarm lamp (RLS), a fuse alarm lamp (FA) and a fuse for each connector.

To the right of the fuse panel (figure 3) are five toggle switches controlling the ringing machine and tone equipment outputs to the shelf. In the OFF position, ringing current, or tones such as ringback tone, busy tone, etc., can be cut off while maintenance is being performed on one or more of the connectors.

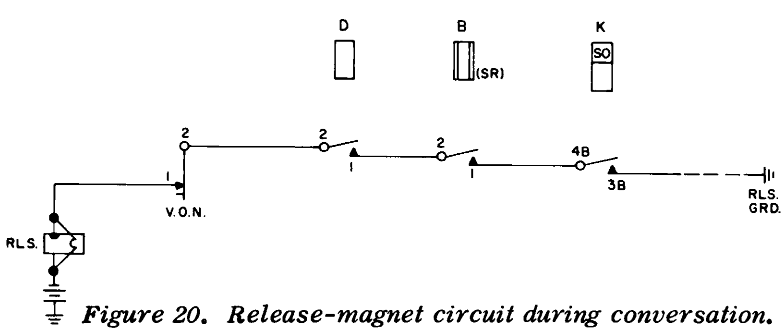


Figure 20. Release-magnet circuit during conversation.

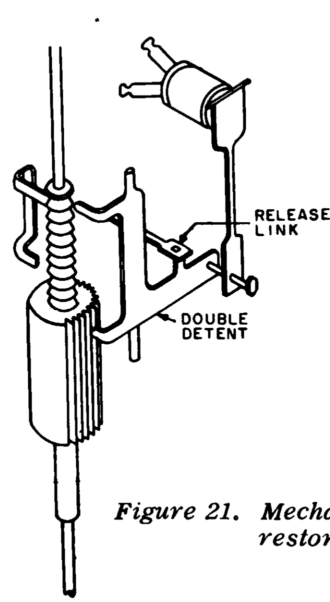


Figure 21. Mechanical restoration.

Immediately below the five switches is the release alarm relay, and the busy tone capacitor. Generally, these components may be located at either end of the shelf.

If the calling party fails to hang up after completing his call, relay D contacts 3-4, relay F contacts 11-12, and relay K contacts 7T-8T complete a ground path to light the SUPY 1 supervisory lamp, indicating that the connector and the called line are being held busy to other incoming traffic by the calling party (figure 22).

In the event the called party does not hang up immediately, SUPY 2 lamp will be energized through relay A contacts 1-2, relay B contacts 3-4, and relay D contacts 6-7, indicating that the connector is being held busy to other incoming traffic by the called party.

7.2 Fuse-Alarm Circuit

If trouble in one of the switches blows a fuse, the red lamp on the fuse panel will light. Figure 23 shows a good fuse and a blown fuse.

When the fuse wire melts, it releases 2 leaf springs, one of which touches a bus bar on the fuse panel, connected to the red lamp. The fuse-alarm circuit also sounds a general alarm, lights an aisle lamp, and a centrally located fuse-alarm lamp.

8. TEST JACKS

The test jacks shown in figure 2 consist of two pairs of springs to which test equipment may be connected to check the operation of a particular connector, or shelf of connectors. Technical Bulletin 755-543 - Operating and

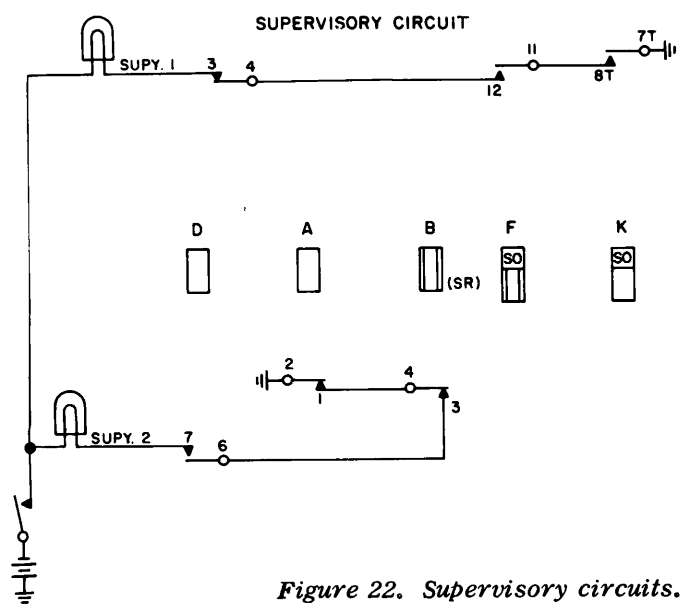


Figure 22. Supervisory circuits.

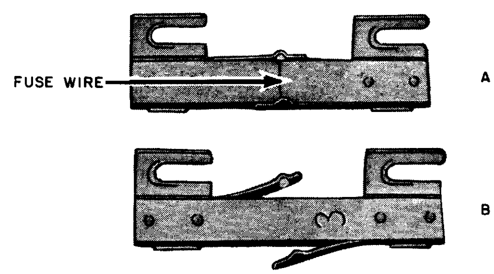


Figure 23. Alarm fuse A - good fuse. B - blown fuse.

7.1 Release-Alarm Circuit

When a mechanical defect prevents a connector shaft from rotating or falling during release, the release magnet will remain operated and cause the green release-alarm lamp on the shelf fuse panel to light after a few seconds. This is accomplished by supplying ground to the release magnet through the low-resistance winding of the shelf release-alarm relay. This relay operates in series with any release magnet on the shelf, and connects the release-alarm lamp to a timer that will light the lamp and sound an alarm to inform switchmen of the trouble. Typical timers for this purpose allow the release-alarm relay to be operated from 9 to 20 seconds before they close the alarm circuits.

Service Inspections, Automatic Central Office Equipment - describes tests to be performed, and their frequency.

8.1 Busy Key

Each switch on the shelf has an associated busy key. Figure 2 shows that this key is mounted immediately above the banks. Whenever a connector is to be tested, or taken out of service for some reason, the busy key is moved to the busy position.

Operation of the busy key (figure 24) places a ground on lead C, and removes the 500-ohm resistance battery which is used to mark the switch idle. This switch then cannot be seized by a selector until the busy key is restored to its normal position.

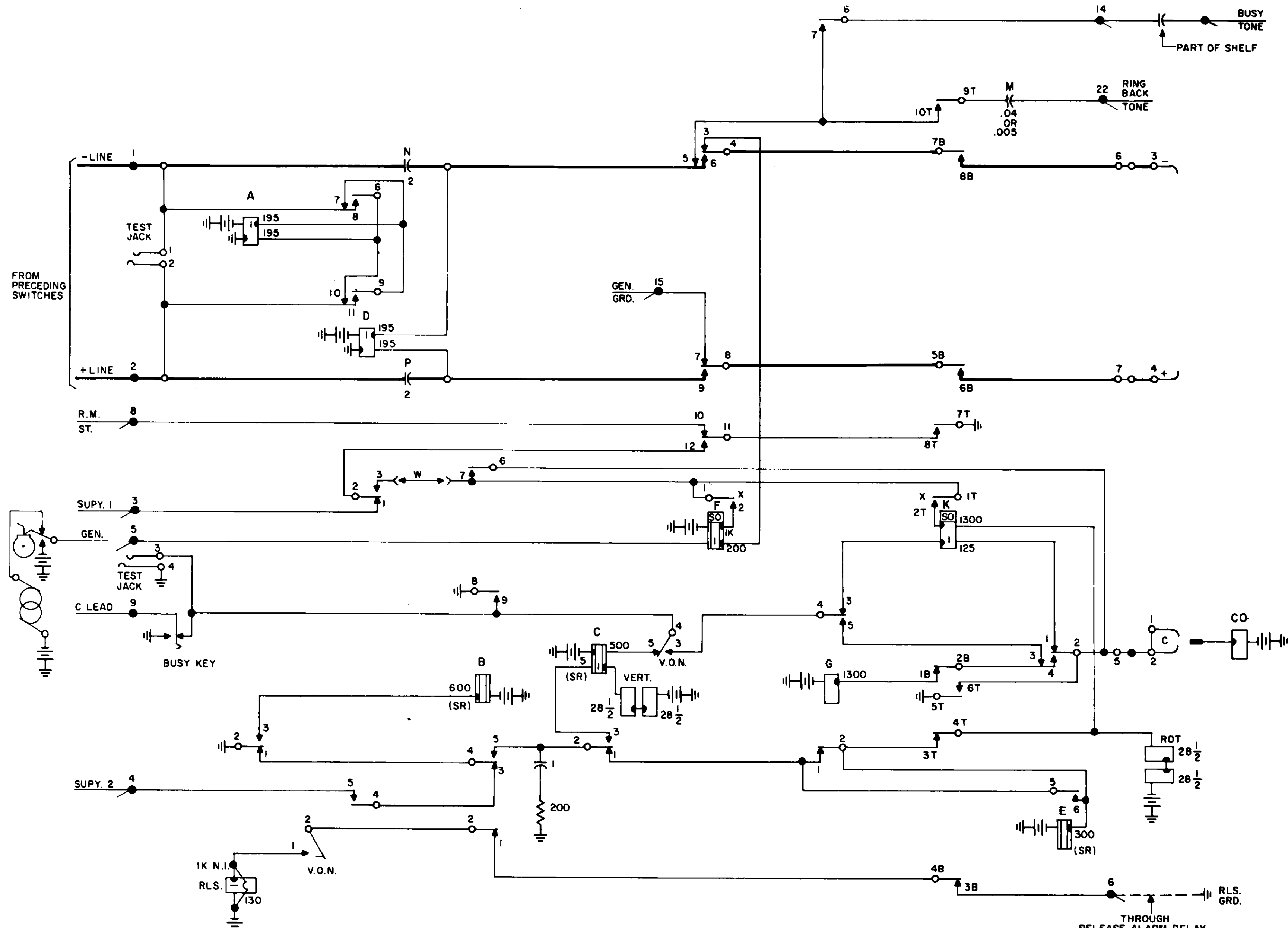


Figure 24. Schematic diagram - local connector.

PART II

FOUR WIRE, 400-POINT BANK CONNECTOR

1. INTRODUCTION

1.1 General

Part II of this bulletin presents a 400-point bank, four wire connector as a comparison to the 300-point bank, three wire connector presented in Part I. The connector selected to be used in this comparison is an eight relay local connector, similar in operation to the connector presented in Part I. Mechanically, both connectors function about the same.

There are two distinct differences between the 300-point bank connector and the 400-point bank connector. The first and most obvious difference between the two connectors is in the number of contacts on the banks. In paragraph 3.1 of Part I, the difference between the two banks of contacts used to make up a 300-point bank was shown. The 300-point bank connector used a 100 point bank of bridging contacts for terminating the C lead, and a 200 point non-bridging bank of contacts for terminating the + and - leads of each line.

Each bank of the 400-point bank connector has 200 non-bridging contacts. One hundred contacts on the control bank are used to terminate the 100 C leads associated with the 100 lines served by the connector. The other 100 contacts on the control bank are used to terminate an extra control lead (EC). With this connector, the EC lead is used in conjunction with party line ringing, as described in Part II, paragraph 2.3.

The second distinct difference between the 300-point bank connector, and the 400-point bank connector is in the ringing scheme used for party line ringing. Part II of the bulletin presents the latter difference in particular.

2. RINGING

2.1 General

Nearly all ringing methods belong to one of two classes of line service: individual line, or party line. When each set of bank terminals (+, -, and C) on a connector in the central office has access to one and only one customer's station equipment, the customer is said to have individual line service. Even if the individual line may have several extension telephones at the station location, it is still afforded privacy with respect to ringing and conversation, and is therefore designated an individual line. Individual line ringing is explained in paragraph 6.6 of Part I.

A party line is a single pair of leads (+ and -) serving a number of telephones. Party line service differs from individual line service in so far as it features distinctive signaling of each party's telephone(s) sharing the line. Privacy is not available on the line.

Two common methods used to ring party lines are:

(a) Multi-frequency ringing - A multi-frequency (harmonic) ringing system uses a variety of ringing frequencies to signal the stations on a party line. Each piece of station equipment has a ringer tuned to a different frequency. Five frequencies are generally employed in this ringing system.

(b) Coded ringing - All of the telephones on a party line are rung simultaneously; however, each customer is assigned a particular signaling code made up of long and short rings. Five codes are generally employed in coded ringing systems. Coded ringing requires only a single frequency of ringing potential.

Each of the ringing methods above can be made to work with different switching equipment plans in the central office. The switching equipment plans are generally classified as terminal-per-line, or terminal-per-station, on the basis of whether the connector terminations represent lines, or individual customer stations.

Theoretically both connectors presented in this bulletin are arranged to work in a terminal-per-station switching equipment plan. (Terminal-per-line connectors employ additional special circuitry to perform their functions - see TB 945-813.) Terminal-per-station switching equipment plans may be of two specific types: frequency-per-shelf, or frequency-per-terminal.

2.2 Frequency-Per-Shelf

This equipment arrangement employs two-digit local connectors equipped with 300-point banks. These connectors are grouped in shelves and fed a ringing potential of a particular ringing frequency, or code. A party line is made up by bridging connector bank terminals from different shelves to the line. A particular station on the party line is then rung by accessing the line from a shelf equipped with the proper ringing frequency.

Each shelf of connectors receives a separate ringing potential of a particular frequency. Therefore, the potential a station receives is dependent on the shelf of connectors to which it is assigned. There is, then, a relationship between a customer's number and the ringing potential assigned to it. The frequency-per-shelf method of party selection places a limitation on the formation of party lines, because any terminal number is inherently rung with only one set frequency.

Frequency-per-shelf exchanges also serve individual lines. In this instance, the individual lines are grouped on the shelves and supplied by a ringing potential of a straight line frequency, with a standard interruption rate.

2.3 Frequency-Per-Terminal

Frequency-per-terminal and frequency-per-shelf types of terminal-per-station exchanges both provide a separate connector bank termination for each customer station. The difference between these two types of exchanges is basically one of flexibility in the assignment of ringing potentials to the called stations on party lines.

With a frequency-per-terminal system, connectors are used which can individually provide any one of the various ringing potentials to the stations assigned to their banks. This is accomplished by use of the EC (extra control) lead. The EC contact on the bank is used to determine which of several ringing potentials available to the connectors is going to be placed on the line at a particular time.

Depending upon which ringing method is used in the exchange, all frequencies, polarities, or codes of ringing potential are supplied in sequence to each connector over a single lead from the ringing generator. A ground pulse from a ringing interrupter relay is applied to the EC contact corresponding to the station to be rung, figure 25. The interval of this ground pulse corresponds to the interval in which the desired ringing potential is applied to the generator lead common to all connectors. The ground pulses are used to operate a ringing control relay in the connector, figure 26, which connects the proper ringing potential to the line for the interval during which it occurs. Each frequency is applied to the common generator lead in sequence, but only the required frequency will be sent out on the line. For each type of discriminatory ringing potential used, the use of the common generator lead and the EC contacts of the connector vary. For a description of these differences, refer to TB 945-804.

3. OPERATION (FIGURE 26)

If the dialed line is idle after the E relay releases, battery through relay CO is encountered by the C wiper which energizes winding

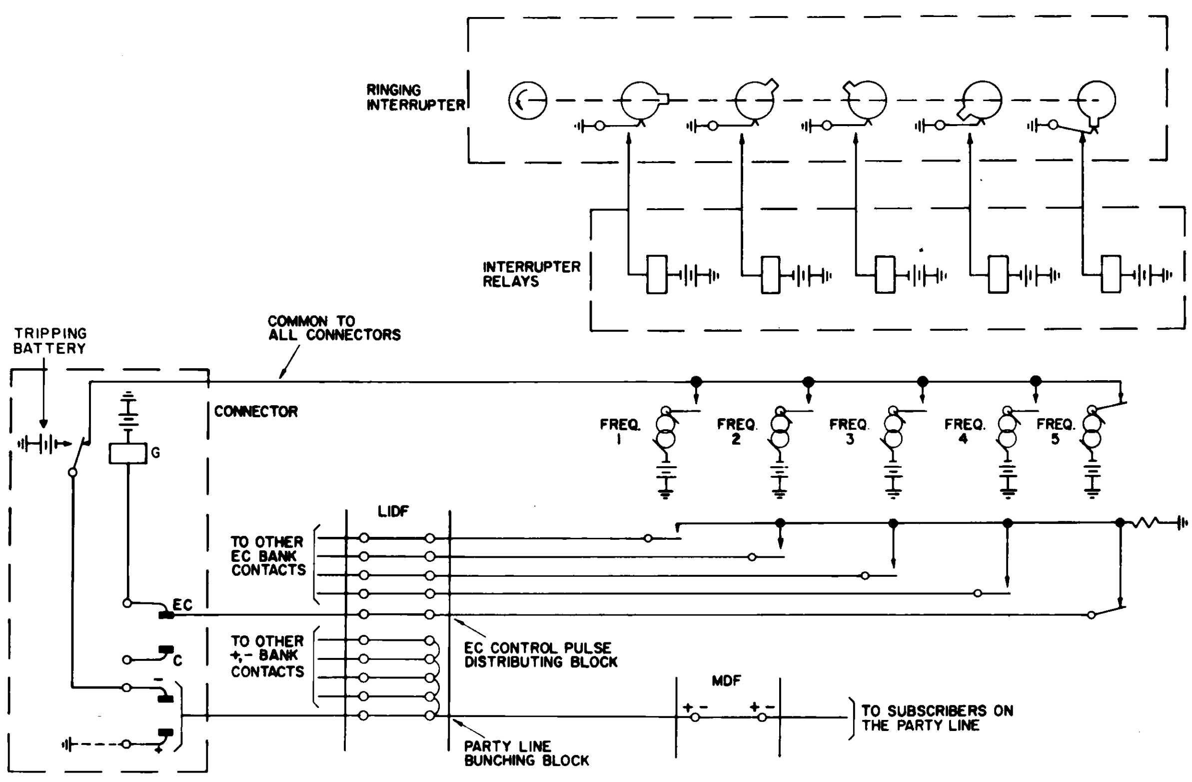


Figure 25. Frequency per terminal ringing scheme.

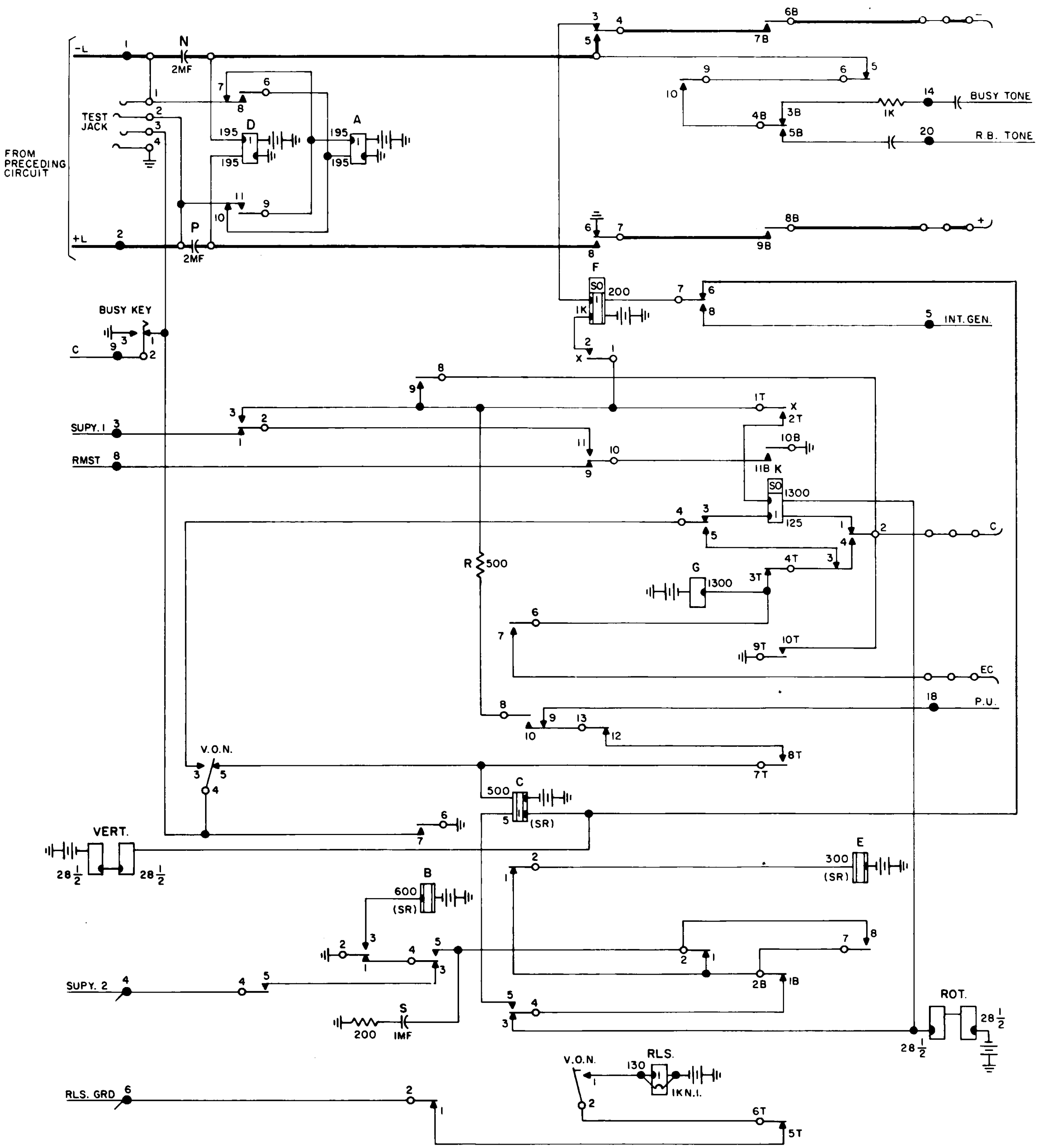


Figure 26. Schematic diagram - frequency-per-terminal connector using 400 point bank.

No. 1 of relay K. Relay K is energized by ground at contacts 6-7 of relay B through V.O.N. springs 3-4, contacts 3-4 of relay G to the No. 1 winding of relay K and battery through relay CO of the called line equipment. Relay K closes its X contacts and sets up a locking circuit through winding No. 2 of relay K from battery at the rotary magnet to ground at contacts 6-7 of relay B. As the K relay operates completely, contacts 9T-10T place a ground on wiper C to hold the cut-off relay in the line equipment operated. Ground through contacts 10B-11B of relay K will start the ringing machine in a small office where it does not run constantly. Contacts 6B-7B and 8B-9B complete the ringing path, and 4B-5B complete the path for ringback tone. Relay K opens contacts 3T-4T placing the G relay under the control of the EC lead by breaking its holding path.

3.1 Coded Ringing

If the office uses coded ringing, contacts 7T-8T of relay K close a path from lead PU (pick-up) through relay C contacts 9-10, and relay F contacts 12-13 to the No. 2 winding of relay C. At the beginning of the first ringing cycle corresponding to the called line, a ground is placed on lead PU which causes relay C to operate, and through contacts 6-7 completes a path to relay G.

When relay C operates for the ringing cycle, it closes its own holding path from ground at contacts 9T-10T of relay K, contacts 8-9 of relay B, through resistor R, its own contacts 8-10, contacts 12-13 of relay F, contacts 7T-8T of relay K, to battery through winding No. 2.

As soon as the called party answers, relay F operates and contacts 12-13 open the holding path to relay C. It releases after its slow to release interval.

Ground is only present on the PU lead at the beginning of the ringing cycle. This ground prevents false codes from being sent if the wipers of the connector happen to be positioned on the terminals of the called line after the ringing cycle has once started. If frequency ringing is used in the office, a permanent ground is placed on the PU lead.

3.2 Frequency Ringing

When a frequency ringing method is used to ring the called party, a ringing interrupter cam grounds the interrupter relay corresponding to the frequency, and also places ground on the EC lead of the connector, figure 25.

Ground closed to lead EC by an interrupter relay causes relay G to operate only while the desired frequency is sent out on the line, figure 25. As the cam rotates, each frequency in turn is applied to the line for a predetermined period, usually 1.2 seconds on and 4.8 seconds off.

3.3 Tripping Battery

Ringing potential as applied to the called line consists of a combination of a periodic a-c potential supplied by the ringing generator and a d-c potential supplied by central-office battery. During the portion of the ringing cycle when the ringing frequency is applied to the line, a capacitor in the telephone blocks the d-c component of the ringing potential, figure 13. If the called telephone is picked up during this time, a d-c path is completed through the hookswitch as shown in figure 14. This d-c path allows the d-c component of the ringing potential to energize the ring cut-off relay, relay F.

During the silent period of the ringing cycle (when the called telephone is not rung), central-office battery (called tripping battery) is applied to the line. Tripping battery allows the ring cut-off relay to energize if the called party takes his handset off hook during the silent portion of the ringing cycle.